University of Alberta

Is the Tragedy of the Commons Possible?: Investigating factors preventing the dissipation of common pool fuelwood rents in Zimbabwe.

By

Richard Lawrence Hegan ©

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Abstract:

This study investigates factors preventing the tragedy-of-the-commons outcome of total rent dissipation for common pool fuelwood resources in a rural village in Zimbabwe. Although village "rules" classify fuelwood resources as being open-access (Kundhlande and Luckert, 1998), theory suggests that social norms (e.g. Sethi and Somanathan, 1996) and/or heterogeneity among users (Cheung, 1970) prevents rents from being dissipated. Several factors that potentially influence household fuelwood collection site choice were identified and included in a Random Utility Model. The results suggest that some social norms and heterogeneous travel costs significantly influence site choice. Welfare measures suggest that there are positive rents associated with the each of the 47 different sites in the model; and sites rents are variable because social norms and/or heterogeneity are preventing rent dissipation at some sites more than others. Given the prevalence of social norms and heterogeneity in costs, it is doubtful the "tragedy-of-the-commons" (ie. total rent dissipation) is possible.

University of Alberta

Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled *Is The Tragedy Of The Commons Possible?: Investigating factors that influence common pool fuelwood rents in Zimbabwe* submitted by Richard Lawrence Hegan in partial fulfillment of the requirements for the degree of Master of Science in Forest Economics.

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1.0 Introduction

Disappearing woodlands in developing countries raise several ecological concerns over issues such as bio-diversity, watershed management, and desertification (e.g. Buckley, 1999; Dudley, 1992; Lourdres *et al.*, 1994; Mortimer, 1998). Also, since rural households often rely on local woodland products, there are concerns over disappearing woodlands and the effects on poverty. This study is concerned with the economic benefits of collecting fuelwood. A case study was carried out in a rural village in Zimbabwe, a country where indigenous woodlands are the only affordable fuel source for a majority of rural households (Campbell and Mangono, 1997). Since switching to fuelwood substitutes (such as paraffin or electricity) is prohibitively expensive, and because tree-planting schemes often lack the necessary incentives for household participation, fuelwood collection is a significant factor threatening the sustainability of all woodland resources in many areas of Zimbabwe.

Since woodlands in developing countries are usually not exclusive to a single economic agent, concerns over disappearing woodlands may be linked to generalizations associated with Common Pool Resources (CPRs)[1]. One generalization is that shared woodlands results in a large number of people competing for the last standing tree to construct their homes or burn as fuelwood. This is the notion professed in Garrett Hardin's (1968) famous essay "The Tragedy of the Commons", where each cattle herdsmen decides to selfishly exploit a communal grazing pasture since the individual costs of over-grazing are transferred to all other herdsmen. The "tragedy" is the inevitable overuse and collapse of a "common" resource when individuals do not account for their collective impacts. Based on this generalization, resource mismanagement and collapse in developing countries has been blamed on traditional institutions that allow shared access (eg. Hitchcock, 1980; Picardi and Seifert, 1976).

However, Hardin (1968) was actually describing an "open-access" resource rather than "common property" (Ciriacy-Wantrup and Bishop, 1975; Bromley, 1991, 1992). Under open-access any individual has access rights to a CPR, while under common property institutions define a group of individuals that have access rights to a CPR.

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[1] In this study the term CPR refers to any arrangement where access to a natural resource is shared.

According to the economics literature, resulting differences between open-access and common property may be described in terms of lost rents. A key difference is that open-access is a necessary condition for the total rent dissipation outcome associated with the tragedy-of-the-commons (Cheung, 1970), and, therefore, under common property total rent dissipation is avoided (e.g. Baland and Platteau, 1996).

Besides differentiating between open-access and common property, there are other complexities surrounding CPR's. One complexity is that some degree of rent dissipation can still occur under common property. In fact, the Property Rights School emphasized that common property will always result in a sub-optimal outcome compared to individualized property rights (e.g. Demsetz, 1967; Field, 1985). However, in challenging the Property Rights School, a vast literature has emerged that is much more optimistic about common property institutions. According to this literature, managing a CPR as common property may be an "optimal" arrangement. (e.g. Agrawal and Yadama, 1997; Bromley, 1992; Baland and Platteau, 1996; Ostrom, 1990, 1994). The literature recognizes that free-riding behavior and rent dissipation can be minimized with institutional exclusivity that excludes outsiders and provides incentives for collective action amongst insiders.

A second complexity is that there are several types of institutions for managing a CPR as common property; ranging from centralized legislation to social norms entrenched in local or traditional practices (Sethi and Somanathan, 1996). Since social norms are not always obvious, and can operate in accordance or contrary to other institutions, it may be difficult to assess the extent and effectiveness of common property regimes.

A third complexity is that heterogeneity among CPR users, in terms of production, also prevents rents from being entirely dissipated (Cheung, 1970). The implication is that individuals may even capture rents for a resource that is open-access. Furthermore, a scenario where CPR users are homogeneous seems unlikely.

Empirically this study was prompted by two previous studies that examined fuelwood resources for a particular village in Zimbabwe. One study found that according to the village "rules", fuelwood resources are open-access (Kundhlande and Luckert, 1998). However, in challenging the tragedy-of-the-commons outcome for open-access resources, the other study identified positive fuelwood rents by using a derived demand approach that found the assumed market value of consumed fuelwood to be in excess of collection costs (Campbell *et al.*, 1997). Therefore, the purpose of this study is to return to the same village and identify any social norms along with heterogeneity factors that may, as theory suggests, be preventing fuelwood rents from completely dissipating.

The village, Jinga Village, is situated in the Communal Lands of Manicaland Province in Eastern Zimbabwe. Communal Lands are areas where blacks were concentrated under colonial rule to practice their traditional methods of subsistence agriculture (Moyo *et al.*, 1991). After independence in 1980, continued government intervention on Communal Lands is thought to have contributed to the erosion of local or traditional institutions for managing CPRs (e.g. Mandondo, 1997; Nhira and Fortmann, 1993; Scoones *et al.* 1996). In Jinga there are still relatively abundant stocks of fuelwood, but concern over disappearing woodlands in recent years[2] may be some indication that traditional institutions are unable to cope with current levels of population growth and in-migration.

As policy makers review government intervention on Communal Lands, they may be helped with a better indication of the roles that local institutions and heterogeneity play in influencing the benefits of an integral resource such as fuelwood. While this study focuses on fuelwood resources of one village, the issue of identifying social norms and/or heterogeneity factors that influence rent levels is potentially relevant to many CPRs in developing countries. Since it is difficult to imagine a CPR scenario where individuals are homogeneous, combined with the fact that social norms may emerge to manage a resource as common property, the question is prompted of whether the outcome according to the tragedy-of-the-commons is possible?

The write-up of this study includes the following chapters: In Chapter 2 the literature is reviewed in two main sections; the first section reviewing the (mostly) economic literature on CPRs, and the second section reviewing literature related woodland resources, particularly fuelwood, on the Communal Lands in Zimbabwe. Chapter 3 outlines the methods involved in using a Random Utility Model (RUM) to analyze factors that influence site choice for fuelwood collection. Chapter 4 presents a brief overview of Jinga Village, background information on fuelwood collection, and specifications of the RUM. Chapter 5 analyzes the results derived from the RUM. Finally, Chapter 6 discusses conclusions and future research.

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[2] Based on discussions with villagers from Jinga.

2.0 Literature Review

A major concern in developing countries is the rapid depletion of woodland resources (eg. Leach, 1999; Murai, 1995; Pearce, 1998; Sierra, 1999; van Kooten, 1999). This is particularly the case in Zimbabwe, where a majority of rural households subsist on many woodland products and services (eg. Campbell *et al.*, 1997; Mandondo, 1997; Matose, 1994; Murphee and Cumming, 1997). Economic theory suggests high rates of natural resource extraction can be part of a welfare-maximizing production path that substitutes inputs of a growing capital stock for depleting natural resource stocks (Stiglitz, 1974). However, high rates of extraction and depletion may also signify that a natural resource is being over exploited and that there is economic waste in the form of dissipated rents which prevents the rent maximizing solution.

Hardin's (1968) *Tragedy of the Commons* and Gordon's (1954) model of a "common" fishery helped to stigmatize CPR behavior as selfish and self-destructive, resulting in total rent dissipation. Subsequently, the Property Rights School advocated individualizing property rights as the optimal evolutionary path for overcoming inefficient resource use (Demsetz, 1967). This notion, that there is a need to reform property rights when access rights are shared, was applied in developing countries where many resources are traditionally held in "common" (eg. Hitchcock, 1980; Picardi and Seifert, 1976). However, as the literature evolved, this stigmatism has been replaced with a greater optimism for the viability of CPR's, noting that Hardin (1968) and Gordon (1954) were actually describing resources that were open-access rather than common property (eg. Baland and Platteau, 1996; Bromley, 1989b, 1991, 1992; Ciriacy-Wantrup and Bishop, 1975; Ostrom, 1990).

This chapter will review some of the economic literature on CPRs. Then, literature relevant to Communal Land woodland resources and institutions in Zimbabwe, with a focus on fuelwood resources, is reviewed as a backdrop for the empirical research and policy considerations of this study.

2.1 Common Pool Resources (CPR's)

The term CPR refers to all arrangements where access to a resource is shared, and where limiting the number of users or the level or appropriation by each user has an effect on the resource (Ostrom, 1990). This section will review different perceptions in the CPR literature on how these arrangement effect rent capture. These perceptions include *The Tragedy of the Commons* paradigm of total rent dissipation; institutions that form property rights; the Property Rights School notion that property rights necessarily evolve towards individual exclusivity; common property as an optimal property rights arrangement; and recognizing that exclusivity and heterogeneity factors can influence CPR rents.

2.1.1 The Tragedy of the Commons: Outcome and Metaphor

In his seminal essay, *The Tragedy of the Commons* (1968), G. Hardin, a population biologist, describes a communal grazing area for cattle where "each man is locked into a system that compels him to increase his herd without limit in a world that is limited" and that "ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons"(p.20). The "system" is that a herdsman receives the full benefits of each additional animal, and he will increase his herd "without limit" because the costs of overgrazing from each additional animal are shared among all herdsmen. The "tragedy" is that this is the conclusion reached by every herdsmen sharing the "commons", and the result is massive over-grazing.

In this review, Hardin's (1968) tragedy-of-the-commons outcome, where "ruin is the destination towards which all men rush", will be defined in economic terms as being equivalent to the outcome of total rent dissipation in H. Scott Gordon's (1954) model of a "common" fishing ground. In Gordon's (1954) model, fishers have unrestricted entry and no catch limit. Analogous to Hardin's (1968) "system", when a fisher enters, he reduces without compensation the catch of every other competing fisher. In other words, benefits from an additional boat exceed the private costs to the individual who owns the boat because a portion of the costs is shifted to the group. In later years this would be described as an "externality" or "free-rider problem" when access in non-exclusive (Runge, 1992).

Gordon's model also assumes additional fishers will enter so long as there are positive rents to be captured. The "tragedy" occurs because in equilibrium marginal benefits are not equalized with marginal costs to maximize rents. Instead, in equilibrium rents that fishers could have captured are completely dissipated as the average benefit from fishing is equalized with the marginal costs of inputs for each additional fisher. The important thing to note is that this outcome occurs when all fishers have unrestricted entry. Accordingly, as several authors would later point out, Gordon's model of total rent dissipation describes an outcome for a CPR that is open-access to any individual, rather than when only a defined group of individuals are allowed access (eg. Baland and Platteau, 1996; Bromley, 1989; Cheung, 1970).

By not discriminating between open-access and other CPR arrangements, Gordon and Hardin helped to stigmatize all CPRs with the tragedy-of-the-commons outcome of total rent dissipation. They also helped to stigmatize CPR behavior according to the tragedy-of-the-commons metaphor of narrowly self-interested behavior. Critics of the tragedy-of-the-commons metaphor, however, must realize that "free-riding" is still valid for much behavior found in CPRs, other than just under open-access, which results in some degree of rent dissipation. That is, although Hardin and Gordon consider results in the extreme cases associated with the total lack of exclusivity, the concepts they introduced may also apply to less extreme cases.

2.1.2 Institutions, Property Rights, and The Property Rights School

As suggested above, the tragedy-of-the-commons outcome may be avoided when institutions specify property rights that create some degree of exclusivity for a CPR. Therefore, the concepts of institutions and property rights will be reviewed, followed by a review of some of the literature by the Property Rights School that emphasizes exclusivity in terms the size of the group that is allowed access to a resource.

2.1.2.1 Institutions

New institutional economics developed in response to divergences from the efficient outcomes hypothesized by traditional neoclassical economics (Furubotn and Richter, 1997). Following Coase's (1960) famous "The Problem of Social Cost", economists recognized that there are transaction costs when information is incomplete. Individuals should then be "steered" in a socially optimal direction. To facilitate this steering, institutions are a "higher level" of decision making for regulating and shaping interactions between individuals, firms and industries who work at a lower "operation level" in determining inputs and outputs (Ciriacy-Wantrup and Bishop, 1975; North, 1990). Institutions are also described as humanly devised constraints for reducing uncertainty by establishing a stable incentive structure (North, 1990).

When investigating to what degree institutions create exclusivity for a CPR by limiting access to a defined group of users, or how use is regulated amongst those who share exclusivity, it is important to understand the various factors that differentiate one institution from another. Literature on this "higher level" of decision making suggests two basic ways in which institutions may be differentiated. First, humanly devised constraints in the form of "rules" may exist at various operational levels (Bromley, 1989a). For example, rules may exist as laws that are imposed by a well-recognized authority and as social norms established by mutual recognized courtesies between households. These social norms may also include patterns of behavior that emerge to serve a collective purpose (Uphoff, 1993, Leach et al. 1997). But while several different types of rules may exist at once, trying to encourage similar or different actions in an individual, a distinction may be made between effective and ineffective institutions at influencing behavior (Ostrom, 1990). Similarly, actual influence on behavior may be different than what was intended by the rules (Berry, 1993).

A second concept for differentiating between institutions, related to rules at different operation levels, are the "organizations" that agree upon and enforce the rules (North, 1990). These organizations include various "authoritative systems" such as government, cooperatives or traditional leaders. Also, a less obvious example of an organization is a group of households cooperating on how they use a resource, based on social norms that may have formed with or without initial intervention by another more obvious organizational authority (Bromley, 1989a; Lewis, 1986). Thus like rules, organizations can also exist simultaneously on more than one level. Accordingly conflict between levels could undermine the intentions of institutions.

2.1.2.2 Property Rights

Luckert and Haley (1990) state that definitions of property are usually based on two primary components: a good (or service) and the "social conditions" that dictate use of the good (or service). Social conditions may be thought as institutions that regulate entitlement and use of a good or service. For example, Ciriacy-Wantrup and Bishop (1975) describe property as a "primary social institution comprised of a bundle of rights in the use and transfer of a natural resource" (p.26). The relationship between institutions and a good is then further understood in the concept of a "right". Bromley (1991) defines a right as the "capacity to call upon the collective to stand behind one's claim to a benefit stream" (p.94). In protecting an individual's right, the "collective", as an institution, is then also imposing duties on others to respect that claim. As such, rights are not an object, but rather a relationship between an individual and others with respect to an object. A "property right" is then the ability to call upon the authority of an institution to support and enforce a claim to a defined benefit stream.[3]

Property rights have also been defined with respect to natural resource use as "the rights and patterns of control over land" (Norton and Alwang, 1993).[4] Since there are often numerous benefits, split in various ways between individuals with different claims, there may be numerous institutional rules and organizations that exist within a property rights structure to facilitate these claims. Haley and Luckert (1990) categorize different sets of rules within a property rights structure according to a number of "characteristics" that restrict or control resource use, and, thus, effect benefit streams. For example, there are rules on who can have access, at what times, under what obligations and for what specific benefit. Institutions that create "exclusivity", by limiting the number of individuals with access rights, are just one of many sets of rules within a property rights structure. In fact Bromley (1991) states there are as many different property rights structures as combinations of social structures. It is then misleading to use discrete labels such as "public", "private", or "common property" to describe different property rights structures (Kundhlande and Luckert, 1998).

As will be discussed below, exclusivity arrangements themselves are highly variable. Therefore, discrete labels are also misleading in just describing exclusivity arrangements.

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[3] This concept of a property right was previously outlined by Ciriacy-Wantrup and Bishop (1975).
[4] Norton and Alwang (1993) actually use this definition to describe "tenures", which for the purposes of this literature review will be considered the same as property rights.

2.1.2.3 The Property Rights School

Early economists such as John Locke and Adam Smith emphasized the importance of property rights for efficient generation and distribution of wealth. This mantra was further developed by the Property Rights School of economists with an edict that when property rights are not clearly defined there is an inefficient allocation of resources (Gordon, 1954; Coase, 1960; Demsetz, 1967, North and Thomas, 1973). Implicit in this edict, but explicit in the Property Rights School literature, is that as a resource becomes scarce, property rights evolve towards individual exclusivity, where only one economic agent has exclusive access rights (ie. private property).[5] Thus, despite numerous characteristics that restrict resource use, "exclusivity" is central for contrasting different property rights structures.

For the Property Rights School, overcoming rent dissipation caused by the narrow self-interested CPR behavior that Hardin (1969) described in *The Tragedy of the Commons*, drives exclusive property rights towards individual exclusivity. In Demsetz's (1967) *Toward a Theory on Property Rights*, he states "property rights develop to internalize externalities when the gains of internalization become larger than the costs of internalization" (p.350). The costs of internalization represent the transaction costs of defining and enforcing exclusive property rights, and the gains of internalization are equivalent to preventing rent dissipation by limiting the number of individuals who share access to a resource. Hence, where marginal costs are equal to the marginal gains of internalization, there is an equilibrium level for defining and enforcing property rights such that a defined group of individuals share access rights to a resource (Anderson and Hill, 1975). However, according to the Property Rights School, there is no stable equilibrium at such a point, because changes, such as in markets or technology, eventually result in benefits exceeding costs, and property rights will become more exclusive.

These equilibrium points along the Property Rights School's evolutionary path suggest there is a set of "partial-exclusivity" points; or rather a kind of institutional

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[5] Rather than using the term *private property*, which infers notions of multiple share owners for a "private" versus "public" piece of property, the term "individual exclusivity" of "total exclusivity" will be used to describe one economic agent having exclusive right to use a resource.

exclusivity spectrum based on excluding outsiders. At one end of the spectrum is open-access, and at the other end is individual exclusivity. All points in between these two extremes are "common property" arrangements.[6] The number of individuals sharing access rights to common property then decreases going along the spectrum towards individual exclusivity.

Regarding rent capture along the institutional exclusivity spectrum, Cheung (1970) showed that total rent dissipation is prevented when institutions limit access rights to a defined group of individuals.[7] However, there is still some rent dissipation for common property (while only considering institutional effects of excluding outsiders) because the amount of rent captured is always less than under individual exclusivity. Furthermore, moving along the exclusivity spectrum towards open-access decreases the amount of rent captured, converging on total rent dissipation outcome at the open-access extreme.

Rent loss for common property is perhaps analogous to the classic "prisoner's dilemma," where despite some degree of exclusivity, there is a lack of incentive to cooperate between individuals, and, therefore, each has a rational strategy to supply excess input at the expense of the others (Dasgupta *et al.*, 1979). As mentioned above, this is the tragedy-of-the-commons metaphor for CPR behavior at work in less extreme cases than open-access, where users receive some pay-off, but it is less than the possible rent maximizing solution In theory a Coasian solution of decentralized side payments between independent individuals could facilitate a pareto optimal solution for common property; but inevitably, high transaction costs suggest "institutional" regulation among those who have access is more appropriate (Baland and Platteau, 1998).

Field (1986) begins to explore institutions that regulate behavior among those who have access to common property by separating the costs of "internal governance"

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[6] As will be discussed below, critics of the Property Rights School (eg. Bromley, 1989, 1992; Ciriacy-Wantrup and Bishop, 1975) were actually the first to use the term *common property* to distinguish a defined group sharing a resource from a resource that is *open-access*. Also, they point out that since property is a benefit stream that flows from an object, and a "property right" is the ability to enforce a claim to a benefit stream, then there are no such things as common property resources, only resources managed as common property. While recognizing this point, this study will continue to use the term 'common property' to describe a resource that is managed by some type of common property management regime.
[7] As will be discussed later in this section, besides institutions that create exclusivity, Cheung (1970) also describes how heterogeneity amongst individuals allows rent to be captured for an open-access CPR.

from the costs of "exclusion". While acknowledging that internal governance combats free-riding, it is assumed that to be effective internal governance costs vary directly with the number of individuals sharing exclusive access rights. An "optimal commons", based on the number of individuals sharing exclusivity, is then established where return on investment in internal governance and return on investment in exclusion are equal at the margin. In accordance with the general theme of the Property Rights School literature, Field (1986) emphasized that as scarcity increases, higher relative returns for exclusion will result in a shift towards individual exclusivity. The underlying assumption is that there are higher returns to the costs of exclusion than to the transaction costs of internal governance (Baland and Platteau, 1998).

2.1.3 Optimal Common Property?

Based on the above review of the literature, it seems that the Property Rights School perceives common property arrangements as being optimal only until transaction costs are overcome and output enhancing adjustments are able to increase the number of individuals excluded from sharing access. However, the more recent literature on common property has criticized this approach for several reasons. First, the Property Rights School does not consider that the transaction costs of establishing and enforcing a higher degree of exclusivity can remain prohibitively costly (Baland and Platteau, 1998; Thomson *et al.*, 1992). Second, there may be significant opportunity costs associated with establishing individual exclusivity over common property. For example, poverty and dependency on a natural resource base can result in income uncertainties, such as the effects of drought, that make common property a rational solution to resource management by pooling risk against uncertainty (Runge, 1992; Nugent and Sanchez, 1998). Another example is that the processes of turning common property into individual property can lead to unequal distribution between individuals, which in turn can create instability and breakdowns in efficient use (Dasgupta *et al.*, 1979). Third, although individual exclusivity can be desirable on efficiency grounds, the Property Rights School expects it to emerge spontaneously and incorrectly assumes "a priori that the main force behind institutional evolution is the search for a more efficient utilization of resources" (Baland and Platteau, 1998, p.646-7). Therefore, it is important to consider the roles of social and political institutions (Baland and Platteau, 1998; Eggertsson, 1990).

Baland and Platteau (1998) then go on to suggest three forces that may induce a sub-optimal evolutionary pattern. First, the role of the state in misdirecting institutional change. For example, state imposed rules in Sahelian forests hindered local resource management which may have been otherwise effective (Thomson *et al.* 1992). Second, levels of exclusion and internal governance may adjust to changes in the technological and economic environment, but, and as ignored by the Property Rights School, their evolution is itself dependent on the initial state of prevailing norms. Thus depending on initial social conditions, such as a culture pervaded by distrust, a sub-optimal evolutionary path can result. Third, existing rights holders could oppose a move towards individual exclusivity because of its distributive effects on wealth. For example, local government structures that are assumed to represent local community interests may in fact show little interest in the poor.

These three reasons by Baland and Platteau (1998) suggest that a sub-optimal common property regime may exist; sub-optimal in the sense that even after accounting for transaction and opportunity costs, there is potentially an alternate property rights arrangement that will increase rent levels. However, this does not rule out that common property may be optimal under certain conditions, just as individual exclusivity may be optimal under other conditions. For example, despite some degree of rent dissipation, the transaction costs of establishing and enforcing more exclusive property rights can mean a common property arrangement is optimal

More specifically, since the Property Rights School failed early on to distinguish between open-access and common property, they also failed to recognize the potential efficiency in which internal governance can manage common property (Bromley, 1989, 1992, Ciriacy-Wantrup and Bishop, 1975). Without the threat of invasion by outsiders, common property users have incentives to improve how a CPR is managed (Panayotou, 1990; Runge, 1986). "Collective" or "strategic interaction" may then spontaneously emerge between common property users to mitigate or overcome the free-rider problem (Baland and Platteau, 1996). The corollary is that contrary to the Property Rights School, returns to the transaction costs of establishing and enforcing institutions such as collective action for creating internal governance are not necessarily exceeded by returns to the costs of exclusion. Therefore, rather than necessarily evolving towards individual exclusivity, common property may then be an efficient arrangement for managing a CPR.

A vast literature has emerged in recent years identifying both characteristics and mechanisms that enhance the likelihood of CPR users organizing themselves to avoid the costs of common property (eg. Baland and Platteau, 1996; Bromley, 1992; Larson and Bromely, 1990; Oakerson, 1992; Ostrom, 1990, Ostrom *et al.*,1992; Panayotou, 1990; Thomson *et al.*, 1992). This includes numerous case studies of successful common property regimes based on collective action. To mention just a few, Cordell and McKean (1992) identify a system of ethical codes for managing sea resources in Brazil they feel are more effective than any government intervention; Somanathan (1991) identifies social norms ranging from informal rules backed by social disapproval to rules enforced by government councils for managing communal forests in the Himalayas in India; and White and Runge (1994) found several socio-economic and landscape factors that can influence collective action for watershed management in rural Haiti, " a region deemed to be one of the least auspicious environments for voluntary collective action in the world."

Case studies are complemented by theory that shows how collective action is possible according to several types of repeated or evolutionary-game-theoretic frameworks (Runge, 1992; Sethi and Somanathan, 1996). As part of these "games," Sethi and Somanathan (1996) outline how, in addition to a central mechanism for creating internal governance, there may also be institutions that foster and enforce collective action in the form of less obvious social norms such as behavior codes or informal rules between individuals. It follows that these "social norms" which facilitate collective action may even preclude a central mechanism.

In terms of the exclusivity spectrum, collective action may certainly enhance rent capture for common property, possibly allowing common property regimes to prevent any type of rent dissipation because of free-riding. Therefore, it seems no longer appropriate to conceptualize decreasing levels of rent capture for a common property resource moving along the exclusivity spectrum towards open-access.

Also, contrary to Field's (1985) model, it seems no longer appropriate to conceptualize separate institutions for those that exclude outsiders and those that create internal governance. This is implied by Eggertson (1990), who points out that besides contributing to internal governance, collective action may also contribute to excluding outsiders. Therefore, in contrast to more explicit rules established and enforced by a central authority, social norms seem to blur the distinction between these two types of institutions for establishing and managing common property. Instead, in terms of social norms, rules that exclude outsiders and organize insiders should be perceived as jointly creating some degree of exclusivity for a CPR.

The importance of social norms for creating exclusivity has made the common property literature generally optimistic about local or traditional institutions for managing common property (eg. Getz *et al.*, 1999; Oakerson, 1992; Ostrom, 1994). However, this optimism in common property does not guarantee the effectiveness of existing local or traditional institutions. As mentioned above, actual influence on behavior may differ from what was intended by the "rules" (Berry, 1993), as there may be conflicts between different levels of institutions and the organizations that enforce institutions. Sethi and Somanathan (1996) also illustrate how changes, such as in prices or technology, may cause social norms to be no longer effective for collectively managing common property. Also, similar to criticism leveled at the Property Rights School for assuming property rights evolve towards efficiency, the main force behind local institutions that instigate internal governance may not be to increase the overall efficiency of CPR utilization. For example, richer members of a community dominating local organizations may result in a management system that only benefits a small sector of the community instead of maximizing overall benefits (Saxena, 1989).

Thus, under many conditions it is unlikely that institutions are effective at creating exclusivity that results in "optimal" common property. For example, some researchers in Zimbabwe feel there is misplaced optimism in common property regimes for managing local woodlands because local or traditional institutions have been eroded by factors such as population growth, migratory pressures and inappropriate government intervention (Campbell *et al.* 2000).[8]

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[8] These will be discussed in more detail in the following section of this chapter.

2.1.4 Identifying Exclusivity and Heterogeneity Factors that Influence CPR Rents

The common property literature emphasizes, among several things, that less obvious social norms, informal rules or behavior codes can create exclusivity, and therefore prevent the total rent dissipation outcome associated with an open-access CPR. This is an important point for policy makers to consider. For example, if the existence of social norms is ignored, and a CPR appears to be open-access, it is wrong to assume that individuals are not receiving any benefit from the resource.

Complicating this picture, and seemingly unrecognized in the mainstream CPR literature, is how even in the absence of any exclusivity afforded by institutions, positive rents can still be captured because of heterogeneity amongst users. This implication is based on Cheung's (1970) re-examination of Gordon's (1954) model of an open-access fishery that drops the assumption of fishers being homogeneous. Subsequently, more recent work in the fisheries literature recognizes that dropping the assumption of fishers being homogeneous and having perfect information has profound effects on the distribution of fishing effort and resulting rent and stock levels (eg. Allen and McGlade, 1986; Wilson, 1990). In this study, however, Cheung's (1970) analysis is more thoroughly reviewed since it explicitly illustrates how heterogeneity, like social norms, can prevent total rent dissipation.

Cheung begins with a discussion on the economic concept of an "externality", and how it should be associated with various kinds of incomplete or inconsistent contractual stipulations that prevent marginal equalities from being satisfied when property rights are being transferred. Like Gordon, he then applies his notion to a marine fishery, where the right to contract is entirely absent, thereby altering constraints on competition and resource allocation relative to the base case where the right to contract was present. Cheung, however, shows that Gordon's outcome of total rent dissipation was incomplete by failing to address two important questions. First, how can the marginal revenue product of all fisher's labour be lower than the wage rate if no fisher will apply its labour when its marginal product is less than the wage rate? Second, what does a fisher maximize if its exclusive right to the fishery is absent?

To answer these questions Cheung's model considers that without collusion among fishers, rent becomes a residual with "every decision making unit maximizing the portion left behind by others" (p.59). In the absence of contractual stipulations, fishers will then enter as long as the residual rent for an individual is positive. With each new entrant, however, the marginal product for all fishers will fall, and to be consistent with the equimarginal rule, each fisher will curtail his efforts. Then by assuming fisher's labor is homogeneous, and that their supply to the industry is perfectly elastic, total rent dissipation is an equilibrium where an infinite number of fishers each contribute the same infinitesimally small amount of effort.

Cheung then relaxes some of the assumptions in his model to explain that the tragedy-of-the-commons outcome of total rent dissipation is unlikely since the entry of fishers is usually finite. First, and as mentioned above, institutional arrangements can restrict entry by creating exclusivity, and, thus, allow rents to be captured. With exclusivity, institutional governance, possibly in the form of collective action through social norms, may then coordinate the efforts of firms. Second, if not all fishers are equally as productive, or have different opportunity costs of entering the fishery, then their labour is not homogeneous. Heterogeneity means not all fishers are on equal footing; therefore, some fishers have a production advantage over others and are able to "capture part of the ocean rent though none has an exclusive right to the fishing ground" (Cheung, 1970, p.63). The advantage may be that some fishers can afford to access the resource, such as travelling to the fishing ground, while others cannot. While the marginal fisher rents are dissipated, the implication is that contrary to Hardin (1968) and Gordon's (1954) tragedy-of-the-commons outcomes, in equilibrium heterogeneity allows rents to be captured overall for an open-access CPR.

Heterogeneity, therefore, is an additional factor other than exclusivity that allows rents to be captured for a CPR. Even in the absence of any institutions directly or indirectly influencing the exploitation of a CPR, it would be hard to imagine a scenario where economic agents are homogeneous in terms of production. Therefore, some level of rents will likely be captured. However, in the absence of exclusivity, there will still be some level of rent dissipation, and, thus, the resource is not being efficiently used.[9]

Though Cheung (1970) does not elaborate much on these two different mechanisms for preventing the dissipation of CPR rents, it also seems appropriate to conceptualize that exclusivity and heterogeneity can prevent rent dissipation simultaneously. For example, consistent with Cheung's model, if instead of being open-access, only a limited number of fishers are allowed to access the fishery, heterogeneity would still limit the amount of rent that may be lost compared to ifthis limited number of fishers were homogeneous.

While heterogeneity can be independent of institutions that create exclusivity, by operating simultaneously there may also be instances where heterogeneity and exclusivity are to some degree co-determined. For example, social norms may develop that give a group of households some exclusivity over a certain fuelwood collection site because they live much closer to it than other households. Conversely, these social norms may discourage another household from establishing a homestead close the site.

From a policy making perspective, it is important to consider the dual effects that heterogeneity and exclusivity have on CPR rents. Consider that the viability of a CPR may be the result of local or traditional institutions that are effective at creating exclusivity and/or heterogeneity. Also, since heterogeneity prevents total rent dissipation, in the absence of institutional exclusivity it is wrong to assume users of a CPR are not receiving any net benefit. This ambiguity suggests policy makers would benefit not only from a framework for identifying less obvious institutions that create exclusivity for a CPR, but also from a framework that considers the combined effects of exclusivity and heterogeneity in terms of preventing CPR rents from being totally dissipated. From the perspective of maximizing rents, policy makers may only be able to directly influence CPR rents by implementing or manipulating institutions that influence access and resource use. Alternatively, heterogeneity, which can be the product of various institutions and/or physical limitations, is perhaps impossible to conceive as policy "instrument" for increasing rents. Still, a framework for investigating institutions at capturing rents should take into account the context of heterogeneity.

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[9] Note this outcome does not consider transaction costs.

2.2 Woodland Resources on Communal Lands in Zimbabwe

2.2.1 Communal Lands

Zimbabwe is described as having three types of property rights structures for land use: State Land, Communal Lands, and Commercial Land (Moyo *et al.*, 1991). As an alternative to state or privately controlled land, Communal Lands were established under colonial rule to relocate thousands of black households relying on subsistence based agriculture after they were forcibly removed from the most arable land in Zimbabwe[10] to allow white-owned commercial farms to be established.

The creation of Communal Lands created a "dualistic" property rights system, where land possessed by whites was governed according to "modern (private)" property rights, and Communal Lands were based on "traditional" property rights enforced and controlled by the system of chiefs (Bruce *et al.*, 1993). Understandably this massive relocation of households disrupted traditional or local institutions by uprooting entire villages (Moyo *et al.*, 1991). Villages were then further disrupted by the government imposing their own laws and regulations on land use on Communal Lands, creating a conflicting sort of internal "dualism" (Bruce *et al.*, 1993).

Since Zimbabwe gained independence in 1980, the government has been purchasing commercial farms for redistribution. These additions to the Communal Areas, called Resettlement Areas, are intended to alleviate congestion on existing Communal Lands (Moyo *et al.*, 1991), where population growth and in-migration have contributed to significant natural resource degradation. The resettlement process itself, however, has also created problems. For example, in Communal Areas and newer Resettlement Areas (where often blacks had previously been tenant farmers) there is conflict between new settlers and traditional local resource use practices (Sithole and Bradely, 1995; Mangono, 1994). In other cases, traditional practices have been able to evolve to changing circumstances (Sithole, 1999).

It seems that despite resettlement efforts, the post-independence government has upheld a dualistic property rights system. Not only do many of the commercial farms

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[10] The country was actually called Southern Rhodesia during colonialism, and was renamed Zimbabwe with independence in 1980.

established under colonialism still exist, but the government has increased its intervention in regulating land use on Communal Lands where control had been largely left to traditional institutions (Mandondo, 1997). Presently, the legal power to create and enforce rules rests mostly at the 'district' level with the Rural District Councils. For example, the Communal Lands Act of 1982 withdrew the rights of the chiefs to allocate land. Supposedly, land allocations are now under the auspices of the Rural District Council, represented in each village by the Village Development Committee (VIDCO) member (Murphee and Cumming, 1991). However, local or traditional institutions still exist for allocating land and managing Communal Land resources. This is because laws and policies handed down by the Rural District Councils are mostly considered ineffectual because of a lack of resources to enforce by-laws and collect levies (Madzudzo and Hawkes, 1996). This limited influence of the government over village affairs is reflected in that households are often uncertain as to the identity of their VIDCO member (Blench, 1998). Therefore, in many villages in the Communal Lands *de facto* management is the hands of local institutions (Mandondo, 1997).

2.2.2 Woodland Institutions on Communal Lands

In general woodland areas in Communal Lands are made up of CPRs that are managed by a complex structure of institutional rules; ranging from national to local laws or rules, and from informal to formal rules or social norms (Mandondo, 1997; Nhira and Fortmann, 1993). It is generally believed that national state policies for woodland use are not contributing to sustainable use at the local level (McGregor, 1991). The main reason is because of conflict between traditional and government institutions for managing woodland resources (Bruce *et al.*, 1993; Mandondo, 1997; Metcalf, 1995). In the past, government legislation has hardly even acknowledged the traditional role of local people in the management of woodlands (Clarke, 1996). Inevitable conflict drives up the cost of monitoring and enforcement, which explains why local people often do not obey or even recognize state laws (Sithole, 1999). Also the conflicting nature of state laws may give locals little incentive to act lawfully. For example, locals will probably not adhere to the Communal Lands Forest Products Act because while it restricts their use of woodland resources, it also allows outsiders to exploit the resources through permits obtained from state agencies land products (Campbell *et al.*, 2000).

The literature cites numerous examples of local or traditional institutional rules, which may be either formal or informal, for controlling woodland use (Bruce *et al.*, 1993; Clarke, 1996; Kundhlande and Luckert, 1998; Mandondo, 1997; Nhira and Fortmann, 1993). There are "village rules", usually enforced by fines payable to the chief, such as the prohibition on cutting cut green wood (ie. living trees or branches) to use as fuelwood. Village rules may also be enforced by superstitious beliefs; for example, the fear of misfortune to one's family for collecting woodland products in woodland areas considered to be sacred and reserved for certain religious activities. There may also be informal rules entrenched in social norms, customary practices or behavior codes, which do not necessarily reflect longstanding traditional institutions; and may instead have evolved in response to increasing scarcity of woodland products. For example, Clarke (1996) found that in some cases local level agreements between households form a kind of "privatization of the common" by staking claim to a particular resource.

Yet in many areas, there has also been a breakdown in these local or traditional institutions for managing Communal Area woodlands (Mandondo, 1997). For example, Sithole (1999) observed a rapid decrease in the area considered sacred for many "sacred woodlands". Besides being undermined directly by government intervention (Nhira and Fortmann, 1993; Scoones *et al.*, 1996; Vermulen, 1994), local institutions have been unable to cope with rapid population growth, in-migration, modernization and economic forces such as the need to for more income generating activities (McGregor, 1995). An example of the latter is that the sale of forest products is considered socially unacceptable but often done more out of necessity (Scoones *et al.*, 1996).

2.2.3 Fuelwood Resources

In Zimbabwe disappearing woodlands are blamed mostly on the clearing of land for agriculture, but also to a large extent on the collection of fuelwood (Campbell and Mangono, 1994). Like many woodland products, fuelwood is integral to the livelihood of most villagers in Zimbabwe's Communal Lands. A majority of households use fuelwood as their primary, or only, fuel source for cooking and heating (Campbell and Mangono, 1994); and such a reliance has had an impact on its scarcity. In 1994 it was calculated that overall, Zimbabwe's existing forest stock can sustain present fuelwood demands. However, many Communal Lands areas have, individually, experienced substantial deforestation from fuelwood consumption rates that are unsustainable (Campbell and Mangono, 1994).

Researchers have traditionally addressed a "fuelwood gap" that will develop as future demand for fuelwood exceeds supply (eg. Anderson and Fishwick, 1984; FAO, 1985). Subsequently, interventionist programs focused on conserving fuelwood and reforestation projects. However, in developing countries such as Zimbabwe, these types of interventionist programs mostly failed to close or lessen the fuelwood gap (Bradely, 1998; Dewees, 1989; Campbell and Mangono, 1994). On the demand side, for example, switching to alternative fuels such as electricity or paraffin was too costly compared to collecting fuelwood which only requires labor as an input for travelling to and from woodland collection sites (Foley, 1985). On the supply side there was often not enough incentives being offered for individuals to participate in treeplanting programs (Mandondo, 1993; Foley; 1991) or programs to keep woodlands from being cleared for agriculture (Campbell and Mangono, 1994).

Failure of these projects to close the fuelwood gap should not suggest that households place little value on woodland resources, and, therefore, do not react to increasing woodland scarcity. For example, researchers in Zimbabwe have found instances where a response to deforestation has been to lower fuelwood consumption and to increase use of alternative fuels (Campbell and Mangono, 1994; McGregor, 1991). Instead, overall failure of these projects illustrates that they did not fully consider fuelwood use within the overall dynamics of rural household production and resource allocation decisions (Bradely, 1998; Dewees, 1989).

2.2.4 Common Property for Fuelwood Resources

In the recent past, and in accordance with the optimism over common property in the literature criticizing the Property Rights School, a "devolution" to traditional or local institutions may have been advocated for much of the declining woodlands (Agrawal and Gibson, 1999; Murphee, 1990; Woodhouse, 1997). The premise was that existing local or traditional institutions are able to manage woodland resources as common property much more effectively than historically ineffective state policies. These institutions were even perceived as being able to overcome pressures on resources from population growth and changing market forces (Agrawal and Yadama, 1997).

However, more recently Campbell *et al.* (2000) feel that numerous studies on the erosion of local or traditional institutions in Zimbabwe illustrate there is a fair degree of "misplaced optimism" in common property systems for managing woodland resources. This misplaced optimism is also generated by a lack of any emerging local CPR institutions as alternatives for managing woodlands. Campbell *et al.* (2000) concludes that reality in Zimbabwe does not conform to the optimism in the common property literature because the latter emphasizes possible outcomes rather than the complexities on the field.

The previous section of this literature review suggests that one of the complexities to understanding CPRs, such as fuelwood, is that both heterogeneity and exclusivity factors influence CPR rents. Perhaps assessments of existing and alternative institutions for managing fuelwood resources can be gleamed within a framework that gauges the presence and effectiveness of both types of mechanisms that influence the value of all CPR resources. Such a framework is presented in the next chapter.

3.0 Methods

In this study, exclusivity and heterogeneity are treated as site characteristics in a Random Utility Model (RUM) for fuelwood collection site choice. RUMs have been widely used to value recreation sites based on a individual choosing to visit a site within its choice set that maximizes utility (eg. Carson *et al*, 1989; Fletcher *et al*, 1990; Morey et al. 1999). The application of a RUM to site choice for fuelwood collection in Zimbabwe follows a model developed by Hatton-MacDonald *et al.* (1998). In this study, institutional factors that influence where a household decides to collect fuelwood are included as site characteristics in the household indirect utility function for collecting fuelwood at specific woodland sites. Economic welfare measures are then used to value fuelwood collection sites and to estimate the effects of removing travel costs and exclusivity on the value of fuelwood rents.

This chapter outlines the approach used to model fuelwood collection decisions within the overall household production process; the RUM framework for modeling fuelwood site choice; economic welfare measures; and the Participatory Research Methods (PRM) used for gathering background information in order to specify a RUM and collect relevant data in a household survey.

3.1 Fuelwood Collection within Overall Household Production

In developing countries, households are generally both producers and consumers of goods and services. As such, several empirical studies have considered fuelwood collection decisions within the overall context of household agricultural production. Amacher *et al.* (1993) consider the choice between collecting fuelwood or collecting substitutes, such as agricultural residues, to meet household fuel demands. Amacher *et al.* (1996) consider the choice between purchasing or collecting fuelwood. Bluffstone (1997) considers the choice between collecting fuelwood or purchasing substitutes such as paraffin.

In general, household production models assume that utility is obtained from goods (and services) that are either purchased or produced. Production decisions are then based on other assumptions such as households allocating their budget of labor time (and capital) on producing goods that are either for sale or direct consumption; labor can be sold or hired between various production sectors; households are price takers for all inputs and outputs; markets exist for all goods; and goods are homogeneous. The various production sectors, in addition to fuelwood collection, may include agriculture, water collection, livestock, collecting other woodland products and earning income in the local labor market.

In theory, specifying a household utility function and a set of production functions, with complete price information, enables an optimal allocation of resources between all production sectors to be determined from a set of first order conditions. In this study, however, a RUM that drops out of the overall household production process is used to model tradeoffs with respect to household fuelwood collection. Similar to Hatton-MacDonald *et al.*'s (1998) observations in rural Zimbabwe, in Jinga the market for fuelwood is very thin or non-existent largely because the sale of fuelwood is prohibited. Also, for a majority of households the marginal rate of substitution exceeds the price ratio for purchased fuelwood and other purchased goods, resulting in a corner solution where no fuelwood is purchased. Therefore, the RUM framework is based on that household fuel and fuelwood decisions are generally constrained to a discrete site choice for trips to woodlands to collect fuelwood.

3.2 Random Utility Model Framework

This section outlines the RUM for analyzing site characteristics that affect site choice for fuelwood collection; the approach used to define household choice sets; and the welfare measures used to analyze fuelwood rents.

3.2.1 Outline of the Model

The following site choice model represents the decision of selecting a fuelwood collection site in order to meet household fuel demands. Assume household i chooses a fuelwood collection site j that provides the greatest utility among J alternatives in a choice set of C_i sites that are available to household i.[11] The utility individual i receives from site j is:

(1) $U_{ij} = V_{ij} + E_{ij}$

where U_{ij} is conditional indirect utility because it is the maximum utility based on choosing site j, and V_{ij} is the deterministic component known to the researcher that is a function of site attributes as well as characteristics of household i. E_{ij} is an independent random error component, a specification that arises from a failure of researchers to able to describe household's choice sets perfectly, while households are assumed to know the best site to choose. Maximum utility from a collecting fuelwood is then:

(2) $U_i = \max(U_{i1}, U_{i2}, ..., U_{iJ}) = \max(V_{i1} + E_{i1}, V_{i2} + E_{i2}, ..., V_{iJ} + E_{iJ})$

and is assumed to be known to the household.

Site j is then chosen from C_{iJ} with a probability equal to the probability that the utility of site j is greater or equal to the utility of any other alternatives in J:

(3) $P(j \mid C_{iJ}) = \Pr(Uij \geq Ujk) \quad \forall\ k \in C_{iJ} \neq j$

Since utility Uij is not directly observed, substituting (1) into (3) gives:

(4) $$\begin{aligned} P(j \mid C_{iJ}) &= \Pr(V_{ij} + E_{ij} > V_{ik} + E_{ik}) \quad \forall\ k \in C_{iJ} \neq j \\ &= \Pr(V_{ij} - V_{ik} > E_{ij} - E_{ik}) \quad \forall\ k \in C_{iJ} \neq j \end{aligned}$$

Assuming the error terms E_{ij} are distributed identically and independently as a Type I Extreme Value Distribution, the probability household i will choose to collect fuelwood at site j is (Ben-Akiva and Lerman, 1985):

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[11] As will be discussed later in this chapter, C_{iJ} can be a different sub-set of sites between households.

$$(5) \qquad \Pr(j) = \frac{e^{V_{ij}}}{\sum_{k=1}^{J} e^{V_{ik}}}$$

which according to Greene (1993) can be estimated as a multinomial conditional logit model.[12]

The conditional indirect utility of household i choosing a site j is then determined by: the amount of resources left over to allocate on all other household production activities; a vector Q_j of physical site attributes at site j[13]; a vector R_{ij} [14] of institutional "rules" attached to the site that influence household i's decision to collect fuelwood at site j; and a vector S_i of socio-economic characteristics of household i. As is further discussed in Chapter 4, "resources-left-over", and certain physical site attributes that vary between households for the same site, are considered as proxies for heterogeneity. Also discussed in Chapter 4, are social norms that comprise the institutional exclusivity that influences site choice.

In site choice models, travel costs are often included as part of term representing "resources-left-over", calculated as income minus travel costs to the site. Travel costs are usually measured according to cash expenditures and/or the value of time spent traveling based on a wage rate. However, with only a very thin labor market in rural Zimbabwe, household income is a probably a poor indicator of available resources and the wage rate is probably a poor indicator of the value of time. Alternatively, Hatton-MacDonald *et al.* (1998) suggests that calories are a more appropriate measure of tradeoffs that influence household production decisions in rural Zimbabwe. If food is in relatively short supply, and households rely mostly on subsistence agriculture, calories probably mean more to a household than the opportunity cost of not earning a wage. Therefore, in this study resources-left-over are calculated as the household calorie budget of household i

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[12] Since the independence of irrelevant alternatives assumption (where the ratio of two probabilities is independent of any change in any other alternative (McFadden, 1974)) is imposed by the multinomial conditional logit model, parameters for the conditional utility function (1) that are calculated among pairs of sites can be generalized to choice sets of any number of alternatives (Morey, 1999).

[13] The vector of physical Q_i includes joint-production opportunities, such as collecting fruits in addition to fuelwood.

[14] The subscript i is included in R_{ij} to allow institutions to vary between households for the same site.

$(HHCALBUDG_i)$[15] minus the calories expended traveling to site j $(CALORIES_{ij})$ [16]: $(HHCALBUDG_i - CALORIES_{ij})$.

Therefore, the deterministic component of the conditional indirect utility is a function of:[17]

$$(6) \qquad V_{ij} = V((HHCALBUDG_i - CALORIES_{ij}), Q_j, R_{ij}, S_i)$$

Note that since the model is static, seasonal variation in institutions are not identified, nor can the model directly discern to what extent institutions, heterogeneity or rent levels have changed over time. Also, since the model does not capture dynamics between households, it also does not include the externalities that result in inefficient rent capture.

3.2.2 Defining Choice Sets

A choice set of C_{iJ} alternative sites must be specified for each household prior to estimating the multinomial conditional logit model in equation (5). Hatton-MacDonald *et al.* (1998) used a "universal" choice set that assumes all households consider the same set of sites (of all possible sites known to the researcher) when choosing a site to collect fuelwood. However, it may be inappropriate to assume that households have equally perfect information regarding which sites are available (Peters *et al.*, 1995). For example,

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[15] For the purposes of this study, $HHCALBUDG_i$ is the household calorie budget per day, and is assumed to be the same for every household in Jinga Village. According to the 1992-94 FAO Food Balance Sheets (FAO, 1996), per caput supply per day of calories in Zimbabwe in 2000. Since the average number of people per household in Jinga is 5 (Campbell et al. 1994), the household daily calorie budget, is, thus, assumed to be 10 000 for every household.

[16] Calories expended while actually collecting fuelwood at the site were not directly considered. However, as discussed in Chapter 4, they may be captured in the "collection difficulty" ratings included in the vector of site characteristics Q_i. Also discussed in the next chapter is a more detailed discussion on how $(HHCALBUDG_i - CALORIES_{ij})$ was calculated.

[17] Including $(HHCALBUDG_i - CALORIES_{ij})$ as a non-linear parameter in the conditional utility function assumes there are no income effects (in terms of the household calorie budget) on site choice, which assumes there is a linear relationship between travel costs and utility. A sufficient condition to include income effects in the model is for $(HHCALBUDG_i - CALORIES_{ij})$ to enter into the utility function in a non-linearly (Morey, 1999); which may also capture additional benefits, such as being able to watch over

a household on one side of a village may not be aware of an existing collection site on the other side of the village. Thus, different choice sets between households are probably more realistic.[18] It then matters how household specific choice sets are specified, because the number and composition of sites included in choice sets can significantly affect parameter estimates for the conditional indirect utility function in equation (6) (Swait and Ben-Akiva, 1987).

Information may be elicited directly or indirectly from households to specify individual choice sets. Peters *et al.* (1995) argue that having households individually specify their choice set, for example as part of a survey, provides a more consistent model of behavior than using researcher-defined choice sets. Therefore, in this study households were initially asked in the household survey to identify all sites that they consider when deciding where to collect fuelwood. However, it was obvious that information from the responses was incomplete since most households only identified the few sites that they regularly visited. Households usually have intimate knowledge of their village surroundings, which suggests that they would know the location and consider the possibility of the many different sites to collect fuelwood at in Jinga. Because of the problem that households were having in identifying these sites, household specific choice sets were constructed by including all sites within a certain radius of the homestead.[19] The radius around the homestead, which was set fairly wide at approximately 2 kilometres, was based on the farthest any household traveled to collect fuelwood in the first round of the household survey.[20]

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one's homestead, when only traveling a short distance to a site. However, specifying the parameter non-linearly (ie. $(HHCALBUDG_i - CALORIES_{ij})^2$) did not increase the model's ability to predict site choice.

[18] For Hatton-MacDonald *et al.* (1998) a universal choice set was appropriate because there were only a few well-known woodland sites where fuelwood was available.

[19] A large radius that often included several sites in a houhsehold's choice set that are never visited presented a challenge in designing household survey questions (see Appendix D for a copy of the survey). Since several site characteristics are household specific, survey questions were designed such that they were compatible with being asked in the hypothetical sense of going to these sites a household does not visit (and assuming households have information on these sites).

[20] As will be discussed in more detail in Chapter 4, data were collected in three separate rounds of a household survey. In the first round, households were asked which sites they consider when choosing a site to collect fuelwood and which sites they actually visited to collect fuelwood over the last week. All sites and homesteads were then mapped out based on these responses from the first round of the survey. (Also included on the map were additional sites and features identified on "resource" maps constructed by villagers during the PRM group discussions.) All aspects of the map were verified with extensive ground-

3.2.3 Identifying and Comparing Heterogeneity and Exclusivity Factors

In this study heterogeneity and exclusivity factors that allow fuelwood rents to be captured are considered to be represented by certain site characteristics in the RUM. Heterogeneity, as a measure of differential collection costs between households, will be reflected in the travel cost parameter $CALORIES_{ij}$ in $HHCALBUDG_i$ - $CALORIES_{ij}$. Though not measuring heterogeneity directly, $CALORIES_{ij}$ is a proxy for heterogeneity that exists between households because of differences in travel costs (since they are spatially separated) to any particular site. It should be noted that $CALORIES_{ij}$ is not a proxy for all heterogeneity between households in terms of fuelwood production. Other factors, such as household size, age, and number of years living in Jinga also represent heterogeneous costs and productivity. Exclusivity factors are more directly represented by the institutions in the vector R_j. Welfare measures may then be used to estimate influences of these factors on fuelwood rents that are being captured.[21]

3.3 Economic Welfare Measures

Welfare measures in economics generally assess the impact on consumer welfare from a change in quality, quantity, or price of a good. These welfare measures tend to be estimates of consumer surplus, in the form of compensating variation, which are discussed below. On the supply side, welfare measures take the form of rent received by producers. However, for the case of fuelwood collection in rural Zimbabwe, households represent both the producers and consumers of collected fuelwood. Therefore, the surplus value received by these households, above and beyond collection costs, does not fit neatly under either of these categorizations. However, the surplus which producing and consuming households received is consistent with the notions of rent dissipation discussed above, and with concepts of compensating variation discussed below. Accordingly, we will be using measures of compensating and referring to these estimates

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truthing. The map was then used to construct the household specific choice sets. See Appendix B for a version of the map.

[21] Elasticity probabilities were also calculated to compare the effects that $CALORIES_{ij}$ and institutions have on site choice. However, they were omitted from the analysis based on the ambiguity of comparing elasticity probabilities of a continuous variable ($CALORIES_{ij}$) to those of either a truncated or binomial variable (institutions); also, the elasticity probabilities showed basically the same results as welfare measures.

of resource rents associated with fuelwood collection. Assuming no income effects, the following is the compensating variation measure of the change in household welfare in terms of calories per trip (Hanemann, 1982):

$$(7)\ \textit{Compensating Variation} = -\frac{1}{\mu}\left[\ln \sum_{j\in C_{IJ}} e^{V_{ij0}} - \ln \sum_{j\in C_{IJ}} e^{V_{ij1}}\right]$$

where μ is the marginal utility of income (or calories in this study), V_{ij0} is the conditional indirect utility of site i before the change, and V_{ij1} is the conditional indirect utility of site i after the change. Hanemann (1982) shows that μ is the negative of the coefficient on the travel cost parameter in the indirect utility function.[22]

Compensating variation measures were calculated for removing site j from a household's choice set. Negative measures of compensating variation for removing a site suggest the household is worse off. Total site rents, or total fuelwood rents after adjusting for site characteristics that represent joint-production opportunities, are then calculated by summing all rents for a particular site across all households with that site in their choice set.

Separate welfare measures were also calculated for reducing calories expended ($CALORIES_{ij}$)to zero and for removing site characteristics that represent social norms that create some degree of exclusivity. The interpretation is that the larger the welfare effect, the more fuelwood rents either of these factors allow households to capture.

In conjunction with a static site choice model, all welfare estimates are representative of when the household survey was conducted. Whether rents levels are decreasing or increasing, and whether they are being maximized over time, cannot be directly discerned from the welfare measures calculated in this study.

3.4 Participatory Research Methods

Background information was essential for identifying parameters to include in the indirect utility function of the RUM and for designing an appropriate household survey to

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[22] Therefore, in this study μ was assumed to be the positive coefficient on $(HHCALBUDG_i - CALORIES_{ij})$

collect data. To facilitate the collection of background information, Participatory Research Methods (PRM) were implemented to reveal features of the geographic and socio-economic landscape that would be difficult as an 'outsider' to observe in a rural village in Zimbabwe. PRM are based on empowering the local community in the process of collecting information (eg. Hatton-MacDonald and Weber, 1998). This approach also helped to introduce and inform villagers about the study, encourage villagers to participate in the household survey, and to collect enough viable data within a limited time frame without being ignorant of village protocols.

PRM for "ground-level" research in developing countries often use techniques such as group discussions, mapping exercises and transect walks with local people to establish a reciprocal rather than hierarchical relationship between the community being studied and the researcher (eg. Chambers, 1994). PRM techniques used in this study were a combination of key informant interviews and group discussions at village gatherings. The key informant interviews were less formal, which involved asking questions at the key informant's house or during walks around the village. The key informants interviewed were a primary school headmistress, a *sabuka* (chief's aide), a shopkeeper, and two women from different households. During the interviews and walks, it was immediately apparent that daily activities involving woodland, agriculture and livestock resources are highly integrated; therefore, the purpose of these interviews was to understand fuelwood collection within overall resource use and institutions which influence household behavior. Information from key informants was also used to develop topics for the group discussions that focused more specifically on fuelwood collection. These topics included institutions that may influence where a household collects fuelwood.

To facilitate the group discussions, a PRM consultant was hired who could speak the local language, Shona, and had experience in previous studies on woodland resources in rural Zimbabwe. Three separate meetings were held, attended by three different groups based on which area their homestead was located within the village. Separate meetings were held in order to spread out some of the topics to be discussed, allowing each topic to be thoroughly discussed without fatiguing a single group. Fragmenting groups according to area also allowed each group to do a thorough job in drawing up a resource of their area that would be used to identify the various fuelwood collection sites in Jinga Village.

4.0 Background Information and Model Specification

This chapter presents some of the background information on Jinga Village, and how it was used to specify the RUM for fuelwood collection site choice outlined in Chapter 3. More specifically, this chapter is organized into three sections: First, a brief overview of Jinga Village is given based on this study and previous studies in the village. Second, fuelwood collection in Jinga, particularly factors that influence where a household collects fuelwood, are summarized based on background information gathered using PRM. Third, parameters specified in the RUM are outlined based on data collected in a household survey.

4.1 Jinga Village

The village of Jinga is located in Eastern Zimbabwe, in the Mutambara Communal Area of Chimanimani District, in Manicaland Province (see map of Zimbabwe in Appendix A). More specifically, Jinga Village is situated as the base of the Chimanimani Escarpment along the Odzi River. Terrain in Jinga varies from undulating hills at the base of the escarpment, to lowland areas along the river. Natural vegetation in the area is primarily mopane woodland (*Colophosperum mopane* with *Commiphora* and *Acacia* spp).

A quick census revealed there are approximately 120 households in Jinga. In 1994 there was an average of 5 people per household (Campbell *et al.*, 1994). Separate homesteads for each household are spread out over the village's 17 square kilometers (see village map in Appendix B). Though Jinga is situated in Natural Region V, where rainfall is generally low and erratic (Campbell *et al.*, 1994), the village is also in an area classified as an "extensive" farming region (see map in Appendix A) where almost every household relies off rain-fed cultivation of (mostly) maize. Households also rely on animal husbandry, mostly in the form of goats and cattle. Very few people earn cash income within the village.

Population growth has had an impact on indigenous woodlands because of land being cleared for agriculture, growing numbers of grazing animals and increased demand for woodland products such as fuelwood and construction poles. Areas of mountain woodland are becoming noticeably disturbed in terms of a decrease in tree density; and virtually all lowland woodlands are disturbed in terms of a low density of trees or entire areas that have been cleared for cultivating maize crops.[23]

Major property rights structures for households in Jinga may be divided between homestead land, garden plots, agriculture fields and woodlands (Kundhalande and Luckert, 1998). While all land in Jinga is held "in trust" by the chief, each household is allocated, for their own exclusive use, a homestead, an agricultural field, and sometimes a garden plot. Homesteads are usually fenced-in areas large enough for a few housing structures, animal kralls, a cooking area, and sometimes a small area for growing vegetables or maize. Agricultural fields range from being less than a hectare to several hectares in size. In order to prevent crop damage, village rules state that during the growing and harvesting season, households have exclusive access to trees within their fields for collecting fuelwood or fruits. After the harvest (in April) households are allowed to access another households' field to collect fuelwood or fruits after the harvest. Also after the harvest, animals from any household are allowed to graze on the agricultural residues within any field; but usually households will try to prevent animals from other households from entering by fencing in their fields. Gardens are allocated on much smaller plots of land, usually along a stream or the Odzi River. Households have exclusive access and use rights to their garden all year long.

According to village rules and general woodland practices, households have the right to graze their animals or collect woodland products from any woodland area in Jinga (Kundhalande and Luckert, 1998). Households from other villages are even allowed to cross over the Jinga border to access the benefits of woodlands; just as households from Jinga are allowed to access other village's woodlands and grazing areas. One villager described woodlands as "belonging to everyone". Hence, Kundhalande and Luckert (1998) describe fuelwood resources as being open-access. However, as will be discussed below in more detail later in this chapter, there are also social norms that suggest households are somewhat restricted in where they may collect fuelwood. There

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[23] Campbell *et al.* (1994) calculated, based on 1986 aerial photographs, that 35% of area of Jinga village had been cultivated, 29% was disturbed and undisturbed lowland woodland and 35% was mountain woodland. These calculations were not revised for this study (since there were no updated aerial photographs), but in conjunction with population growth of around 20% since Campbell *et al.*'s (1994)

are also three sacred woodlands that are reserved for gatherings and traditional ceremonies. It is prohibited for anyone to collect fuelwood and most other woodland products from these sites. More specifically they are the Dambakurimwa Forest, an area around the Garawakafara Spring and Chaseyama Mountain (see map in Appendix B). Disrespecting sacred woodlands is believed to bring 'misfortune' to the family. Generally villagers respect sacred woodlands; but as evidence that traditional institutions are being challenged, over the last few years the woodland area around Chaseyama Mountain considered to be sacred has been shrinking.

4.2 Fuelwood Collection in Jinga Village

Factors that influence household fuelwood collection in Jinga, particularly factors that influence site choice for collecting fuelwood, will be summarized according to: household fuel decisions, fuelwood uses, desirable characteristics and species preferences, species location and availability, joint production opportunities, institutions, seasonal collection variation, and the location of different fuelwood collection sites. All information in this section was either collected or confirmed using PRM.

4.2.1 Household Fuel Decisions

Daily household fuel requirements in Jinga are almost exclusively met by collecting fuelwood from woodlands. Since the Rural District Council prohibits the sale of fuelwood unless a permit is obtained[24], the market for purchased fuelwood is very thin. There is also little evidence of fuelwood substitutes being used. Only one or two households purchase paraffin as a substitute for fuelwood. Non-purchased substitutes, such as cattle dung, were also not used because of high opportunity costs, and that they do not burn as well as wood.

Household fuelwood collection is almost entirely the responsibility of women. Occasionally small boys will accompany their mother, aunts or sisters on fuelwood collection trips. Men will participate if a scotch cart (a large two-wheeled cart usually pulled by a donkey) or wheelbarrow is used to collect a large load of fuelwood; but they

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study, it was obvious that the area of cultivated and disturbed mountain and lowland woodlands had increased significantly.

[24] At the time of this study no one from the village had a permit to sell fuelwood.

are rarely used because of the hilly and rocky terrain in Jinga. Therefore, women and girls are collecting fuelwood mostly by the headload. An average headload is quite heavy;[25] which may partly explain why women seem to travel to only one site per trip to collect fuelwood and usually only make one trip per day.

4.2.2 Fuelwood Uses, Desirable Characteristics, and Species Preferences

There are several household uses and co-uses for fuelwood. Table 1 is a list of the most common fuelwood uses identified by villagers. Though not indicated in Table 1, by far the majority of fuelwood is used for cooking; and in the winter months of May though August a significant amount of fuelwood is used for heating. Other uses in Table 1 are much less frequent, usually reserved for special occasions.

Fuelwood use determines which burning characteristics are most desirable. Table 2 is a list of "desirable" fuelwood burning characteristics identified by villagers. For example, slow burning wood is preferred for the longer process of beer making; alternatively, little smoke and high heat is desirable for cooking *sadza* (the staple food made from ground-up maize) and heating homes. Burning characteristics are influenced by factors such as tree species, size of the fuelwood pieces and how long the pieces have been left to dry.

Table 3 ranks the 16 most preferred fuelwood[26] species according to a representative group of households from one area of Jinga.[27] Since the majority of fuelwood is used for cooking and heating, ranking some species over others probably reflects that certain species have more desirable characteristics for such primary purposes.

Besides burning characteristics, there are several other factors that might influence species preference. Some of these factors are probably related to the difficulties listed in Table 4 that villagers expressed in terms of collecting fuelwood. For example, although it may have desirable burning characteristics, a tree species may not be preferred because it gives off splinters or is a common nesting place for wasps. Also, a

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[25] A headload of fuelwood is a fairly standard unit of approximately 30-40 lbs.
[26] The 36 different tree species identified in this study as being used for fuelwood are listed in Appendix C. Botanical names in both Appendix C and Table 3 were taken from Campbell *et al.* (1994).
[27] Recall PRM group discussions were organized according to where households lived.

tree species may not be preferred if only available at woodlands associated with snakes (because poisonous or not snakes are adamantly feared by all villagers) or having to traversing over hilly terrain to gain access. In fact, many problems listed in Table 4 are not directly related to tree species, or even directly related to the fuelwood collection site; and are instead fuelwood collection problems related to homestead location.

Tree species and woodland areas with relatively abundant fuelwood stocks are not distributed uniformly around the village. Many species prefer either low or highland woodlands (see map in Appendix B); and highland woodlands have generally more abundant stocks of fuelwood. Depending on where a household lives, since not all households live in the same location, some households will have more problems than others accessing a certain fuelwood species or sites with abundant stocks. Hence, preference for a particular species, or a particularly well-stocked site, will also vary across households. Species rankings in Table 3, therefore, do not represent overall species preference in Jinga; but they do illustrate by way of example that households preferred certain fuelwood species to others.

Table 1: Uses/Co-uses Of Wood Collected For Fuelwood.

- Cooking
- Heating
- Brick making
- Firing pottery
- Ironing
- Beer Brewing
- Church gatherings
- Funerals
- Gifts at weddings, births,
  And visits to the sick.

Table 2: Desirable Fuelwood Burning Characteristics

- Charcoal that sustains heat.
- High heat
- Little smoke
- Few sparks, and smooth combustion.
- Slow burning
- High quality ash to use as a cooking ingredient or fertilizer.
- Produces little ash.
- Little bark to remove.
- Useful outside bark (fuel for bread making and firing pottery, rope)
- Dry
- Insect resistant
- Easily split
- Odorless when burning.
- Does not absorb much rain.

Table 3: Preferred Fuelwood Species (With Rankings)

Rank	Species	Local Name
1	*Combretum molle*	Mugodo
2	*Colophosperum mopane*	Musharu
3	*Dalbergia melanoxylon*	Muhweti
4	*Julbernadia globiflora*	Mutondo
5	*Brachystegia spiciformis*	Musasa
6	*Brachystegia glauceseus*	Muunze
7	*Afzelia quanzensis*	Mukamba
8	*Strychnos madagascariensis*	Mukwakwa
9	*Terminalia sericea*	Mususu
10	*Diospyros quiloensis*	Mukukuti
11	*Cassia abreviata*	Muremberembe
12	*Acacia nilotica*	Muguvhungu
13	*Dichrostachys cinera*	Mupangara
14	*Grewia inaequilatera*	Mutezwa
15	*Kirkia acuminata*	Mutuwa
16	*Sclerocarya birrea*	Mupfura

Table 4: Problems Encountered Collecting Fuelwood.

- Encountering wasps
- Accidents from using an axe or ones hands to cut or break wood into pieces.
- Shortage of tools (primarily axes).
- Splinter and thorns
- Snakes
- Falling while carrying a headload of fuelwood.
- Traversing hilly terrain.

4.2.3 Joint Production with Fuelwood Collection

Fuelwood collection is often in joint production with collecting other woodland products, or participating in other household activities, at or along the way to a fuelwood collection site. Table 5 lists the most common joint production activities identified by villagers. In addition to the activities listed in Table 5, it was also expressed that collecting fuelwood is one of the main opportunities for women to socialize. Women from different households will even organize themselves ahead of time into groups to collect fuelwood.

Table 5: Possible Joint Production Activities with Fuelwood Collection.

- Collecting mushrooms
- Collecting fruits
- Collecting reeds/grass to make brooms
- Collecting mopane worms
- Collecting wild vegetables
- Trapping small birds
- Collecting bark to make rope
- Visiting friends
- Checking fields or garden
- Bathing
- Collecting medicinal herbs

4.2.4 Seasonal Collection Patterns

Frequency of trips to collect fuelwood is seasonal. Collection is intensified during the winter months (May through August), in between harvest and planting seasons, when labor is not as scarce. The purpose of going on more frequent trips is to create *baquas* (stock piles of fuelwood) to be used when labor is much more scarce during the harvest season in March and April. During the harvest season, men, women and children spend most of their time working in the fields. Often fuelwood is collected and brought to the fields to cook meals instead of taking time out to cook and eat at the homestead.

4.2.5 Institutions

Various institutions were identified that may influence fuelwood collection behavior. Table 6 is a list of 8 possible institutions that were either directly identified or indirectly implied in talking to villagers. They range from being well-known village rules to more informal controls via social norms between households.

Table 6: Institutions for Fuelwood Collection.

1. Sale of collected fuelwood without a permit is prohibited.
2. Cutting trees or branches that are green (living) is prohibited.
3. Certain species are considered sacred and are protected from being used for fuelwood.
4. Collecting fuelwood at most sacred places, graveyards, ceremonial areas, or around wells and springs is prohibited.
5. Collecting fuelwood from another household's field, including trees in close proximity to the field, is considered improper unless permission is granted.
6. Collecting fuelwood in close proximity to another household's homestead is considered improper unless permission is granted.
7. Households from one side of the village, travelling across the village to collect fuelwood at sites "near" another homestead, would not be "welcome".
8. People from other villages would not be "welcome" collecting fuelwood at certain sites in Jinga.

The first four institutions listed in Table 6 were identified as well-known village rules that restrict fuelwood collection "practices". Prohibition on the sale of collected fuelwood and the cutting of green trees are recognized as being jointly imposed and enforced by the Rural District Council and Chief Jinga. In reality, however, only the chief and his *kraalheads* (lieutenants) directly enforce these rules. No one could even recall an official from the Rural District Council ever coming to Jinga to ensure these rules were being followed. Furthermore, at the time of the study no one in the village was even recognized as being the VIDCO member that represents the Rural District Council. Villagers can report violators to the chief via one of his lieutenants, but this is rarely done. Reporting violators is rare, not because an offence is rarely committed, but because villagers usually prefer to "mind their own affairs". Especially in the case of cutting green trees, the rule is simply ignored because many households commit the offence, and the general perception is that there are still enough trees to support the practice. With respect to the third and fourth "rules" in Table 6, prohibition from collecting fuelwood from certain trees or woodlands that are considered sacred or protected is enforced by the fear that a violation resulting in misfortune to one's family. Villagers indicated that these rules are never broken. However, as discussed above, for one site the actual area considered to be "sacred" has been shrinking.

The last four institutions in Table 6 are more informal rules or social norms for restricting where a household may collect fuelwood. [28] With respect to the fifth and sixth institutions in Table 6, collecting fuelwood in close proximity to another household's homestead or field without permission is acknowledged as breaking an "understanding" between households. Further questioning revealed that "close" to a homestead was within around 75 metres and "close" to an agricultural field usually referred a small area of woodland bordering on the field. In terms of household's whose fields share close proximity to the same woodland area, it seems they can collect fuelwood around each other's fields without having to ask permission.

With respect to the last two institutions in Table 6, being made to feel (or making others feel) "unwelcome" for collecting fuelwood at certain woodland sites is more a reaction to discourteous behavior than breaking an acknowledged understanding between households. Specifically, it seems that this feeling of being made to feel "unwelcome" applies to circumstances when a villager from one side of the village traveled to other side to collect fuelwood and when villagers from another village collect fuelwood at certain sites in Jinga.[29] One villager said that a woman from the other side of the village coming to her side of the village to collect fuelwood might be accused of "spying" or

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[28] As mentioned above, Kundhalande and Luckert (1998) suggest there is also a rule imposed by the chief that prohibits collecting fuelwood within another household's field before harvesting so as to prevent crop damage.

[29] It was not clear from talking to villagers which sites specifically are people from outside the village discouraged from collecting at. It probably depends from which village an outsider resides. It seemed that someone from an adjacent village would be allowed to collect at some spots, while, for example, someone from another region of Zimbabwe would be chased out of Jinga for collecting fuelwood.

being "up to no good". In general, it is expected that this feeling of being "unwelcome" is an effective deterrent to collecting fuelwood at certain sites because of the importance of being in "good standing" with other households. In times of crisis, such as a death in the family, households within the village often rely on each other for help. Similarly, harmonious relations between villages are also important, and provide an incentive to avoid making people from a near-bye village upset.

Despite the village "rules" saying fuelwood resources are open-access, if site characteristics in the RUM recognize social norms are significant there may be some degree of institutional exclusivity.[30] Some of these institutions seem to be embodied within an overall social dynamic within the village that emphasizes interactions between households. Households always seem to be interested in knowing about the activities of their neighbors. These social interactions may also reflect collective action behavior in terms of households policing each other in an effort to make sure resources such as fuelwood are not being over-exploited. For example, besides the practice of asking other households for permission to collect at certain sites, collective action may also be reflected in that woman from different households will talk with one another about where they collect fuelwood and sometimes accompany each other to a woodland site to collect fuelwood. While this behavior may not be labeled as "collective action" according to agents that consciously organize and regulate each other's behavior in order to maximize rents, it may still reflect behavior that reduces to what extent one household can over-exploit fuelwood resources at the shared expense with other households. How these social norms were specified in the RUM is discussed in Section 4.3 .

4.2.6 Fuelwood Collection Sites

Several different fuelwood collection sites[31] currently used by Jinga residents were identified in constructing village resource maps as part of the PRM group discussions.[32] These sites include woodland areas adjacent to Jinga Village in a

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[30] Since it is prohibited for households to collect fuelwood at most sacred woodland sites, those sites assumed not to have fuelwood resources.

[31] As will be pointed out in discussing the survey data, 47 different fuelwood collection sites were identified. These sites are currently used throughout the year by at least one household in Jinga.

[32] Recall that several other features, besides sites, on the map of Jinga Village in Appendix B were also identified in constructing these PRM resource maps.

neighboring village, mountain woodlands, lowland woodlands along the Odzi River or one of the several streams in Jinga, and separate lowland woodlands in close proximity to agricultural fields. Some fuelwood sites are close or attached to one another, but villagers were consistent in distinguishing between the different sites by referring to their distinct names. Often the name of a woodland collection site refers to the mountain or stream associated with the site. Some smaller woodland sites did not have names, but were still considered distinct sites, especially those smaller sites in close proximity to an agricultural field. Several areas of very sparse trees[33] also did not have distinct names, but were still identified as separate fuelwood sources from other denser woodland sites.

4.3 Model Specification and Household Data Collection

Given the above, the probability that household *i* will take a trip to site *j* is then a function of:[34]

(8) *Probability of HOUSEHOLD$_i$ Taking a Trip to SITE$_j$ =*

f(Calories$_{ij}$ (as a measure of travel cost) left over for
all other household activities;
Social norms$_{ij}$[35] *that restrict households visiting SITE$_j$;*
Social norms$_{ij}$ that encourage collective-use of fuelwood at SITE$_j$;
Joint production opportunities$_{ij}$;
Species and overall fuelwood availability$_j$;
Socio-economic characteristics of the household$_i$)

4.3.1 Survey Timing and Sample Size

A household survey was carried out in 1999, during the month of May when the harvest season was finished and household had begun to make more frequent trips to

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[33] These areas seem to correlate with the "disturbed lowland woodland" areas identified by Campbell *et al.* (1994).
[34] Assuming no income effects, and assuming no other socio-economic attributes of the household influence site choice.
[35] A subscript *ij* means that a 'site characteristic' varies between households for the same site. For example, a social norm may only discourage certain households from visiting a particular site.

collect fuelwood.[36] Out of 120 households in Jinga, a 101 were selected to take part in the household survey based on being permanent residents and not having participated in a preliminary "test" survey. The response rate was 100 percent. The survey was carried out using locally hired and trained enumerators. Each household was visited three times, spread over three separate weeks[37] so as to prevent respondent fatigue and gather more accurate information by only asking households to recall which sites they visited during the past week. Sample size for the site choice model is the total number of separate trips to any site to collect fuelwood for all households. Due to incomplete information on household specific site characteristics, data from only 94 households were used to yield a sample size of 824 trips to 47 different sites.[38]

4.3.2 Calories Expended

Consistent with specifying ($HHCALBUDG_i$ - $CALORIES_{ij}$) as "calories-left-over" in the indirect utility function, calories expended ($CALORIES_{ij}$) traveling to and from a sitewere calculated based on: distance from the homestead to the site ($DIST_{ij}$) [39]; assuming one adult woman and one child collected fuelwood on the trip, rates of calorie use by the woman and child were 374 cal/hr and 259 cal/hr respectively[40], and the average rate-of-travel was 1.8 km/hr.[41] Therefore, calories expended were calculated as:

(9) $$CALORIES_{ij} = 2 \text{ x } DIST_{ij} \text{ km x } (259 \text{ cal/hr} / 1.8 \text{ km/hr} + 374 \text{ cal/hr} / 1.8 \text{ km/hr})$$

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[36] See Appendix D for a copy of the household survey.

[37] The three survey rounds are Weeks 1, 2, and 3 of the household survey in Appendix D.

[38] See Appendix E for a list of all sites.

[39] Distances were measured on a scaled map Jinga Village that was constructed using on a topographic map of the area, extensive ground-truthing of all sites and homesteads, and the resource maps constructed as part of the PRM group discussions (see Appendix B for a version of the scaled village map). The easiest route was measured based on the extensive network of paths in the village that seemingly allow a straight line to be traveled to most sites, taking into account mountains or rivers.

[40] Rates of calories expended were calculated at http://primusweb.com/fitnesspartner.

[41] Average rate-of-travel was calculated from responses to the survey question "how long were you away from home", not responses to the question "how long would you be away from home" for sites not regularly visited (see survey in Appendix D). Since responses for the later seemed to be exaggerated upwards, even though some of these are not necessarily far from the homestead, time-away-from-home responses for all sites in a household's choice set were not used directly to calculate calories expended. Instead, for actual trips recorded in the survey, distance to and from the site was divided by time-away-from-home (minus the time it takes to collect a headload of fuelwood), and then averaged across all trips to calculate an average rate-of-travel. The time it takes to collect a headload of fuelwood was assumed to be around 25 min, based on discussions with villagers.

Since households value calories for other household activities, it is expected that the more calories expended travelling to a site, the lower the probability of visiting a site. Thus, for ($HHCALBUDG_i - CALORIES_{ij}$) specified in the indirect utility function of the RUM, it is expected that the more calories left over, the greater the probability of visiting a site.

The above equation (9) for calories expended does not explicitly account for the difficulty of terrain traveling to the site, nor does it account for calories expended while collecting at a site. To account for terrain effects, and that collecting a headload of fuelwood may be easier at some sites than others, households were asked to rate the difficulty of travelling to and collecting fuelwood at each site in their choice set. Table 7 illustrates how site characteristic variables $DIFFICULTL_{ij}$ and $DIFFICULTM_{ij}$ were defined, using binomial coding, according to whether the "difficulty" for household i traveling to site j was rated as being "Easy", "Moderate", or "Hard". It is expected that the higher the difficulty rating the lower the probability of household i visiting site j. (With the effect of a moderate difficulty rating being indeterminate.) These difficulty ratings may also reflet heterogeneity, since difficulty in terrain will depend on the direction a household travels to a site. But they may also capture the difficulty of actually collecting fuelwood at a site, for example depending on how steep the slope is, which does not necessarily vary between households.

To also account for differences between sites in calories expended while collecting fuelwood, overall fuelwood availability was also used as a proxy to measure the effort it would take to collect a headload of fuelwood. Overall fuelwood availability at each site is based on being ranked as having "Low", "Medium", or "High" availability.[42] Table 8 illustrates how the binomial site characteristic variables $AVAILL_j$ and $AVAILM_j$ were coded to represent these rankings of overall fuelwood availability. It is expected that the higher the overall fuelwood ranking the higher the probability household i visits site j, because in general the more fuelwood there is the easier it can be collected. (With the effect of medium overall availability being indeterminate.)

Table 7: Binomial Coding for Difficulty Rating Variables.

Rating:	Variable: $DIFFICULTE_{ij}$	$DIFFICULTM_{ij}$
Easy	1	0
Moderate	0	1
Hard	0	0

Table 8: Binomial Coding for Overall Fuel Availability Rating Variables.

Rating:	Variable: $AVAILL_j$	$AVAILM_j$
Low	1	0
Medium	0	1
High	0	0

4.3.3 Social Norms Restricting Which Sites a Household Visits

As indicated by the PRM background information in Table 6, social norms may discourage fuelwood collection in a number of locations. If effective, these social norms may preclude fuelwood resources from being open-access. However, since it is formal village rules that suggest fuelwood resources are open-access, it was felt that households would not readily admit to requiring permission or feeling unwelcome at some sites. Alternatively, the following variables attempt to capture some of the norms and courtesies that create institutional exclusivity by restricting which sites a household may visit.

The first variable is based on social norms of having to ask permission to collect at some sites: These norms are believed to make household *i* feel unwelcome by "other" households, and thereby discourage the collection of fuelwood at site *j*. The degree to which a household feels unwelcome, may be expressed along a spectrum. At one extreme are sites where a household would be least likely to feel unwelcome. It seems fuelwood sites in close proximity to their own homestead or agricultural field represent this extreme. At the other extreme, it seems a household would be most likely to feel

[42] Based on a ranking exercise amongst villagers who had extensive knowledge of all areas of the village.

unwelcome if the site is in close proximity to somebody else's field.[43] Between these two extremes, it seems a household is made to feel increasingly unwelcome as the number of other households that live in close proximity to a site increases. The probability of feeling unwelcome approaches that of a site in close proximity to somebody else's field as the number of other households in close proximity to site *j* increases, adjusted for the area of the collection site.

Using this logic regarding social norms of feeling unwelcome, four "intermediate" variables were then used to construct a variable to represent the degree in which household *i* is being made to feel "unwelcome" collecting fuelwood at site *j* ($UNWELC_{ij}$):

(10) $JUSTCLOSE_{ij}$ This variable indicates whether site *j* is within 75 m. of the homestead of household *i*.

$JUSTCLOSE_{ij}$ is equal to 1 or 0.

$JUSTCLOSE_{ij} = 1$ if site *j* is within 75 m of household *i*.

$JUSTCLOSE_{ij} = 0$ if site *j* is outside 75 m of household *i*.

(11) $AGFIELD_{ij}$ The purpose of this variable is to characterize the proximity of site *j* agricultural fields.

$AGFIELD_{ij}$ is equal to 1, 2 or 0.

$AGFIELD_{ij} = 1$ if site *j* is in close proximity to the field of household *i*.

$AGFIELD_{ij} = 2$ if site *j* is in close proximity to a the field of any household other than household *i* (ie. household $\neq i$).

$AGFIELD_{ij} = 0$ if site *j* is not in close proximity to any agricultural field.

[43] Note that collection may also be discouraged close to another household's homestead. However, this discouragement is likely to be less than in areas that are next to another household's field, because woodlands next to fields tend to be smaller and thus more highly prized than woodlands next to homesteads. Accordingly, the most unwelcome end of the spectrum is defined as being in close proximity to "other" household's fields.

(12) $NUOHHJC_{ij}$ This continuous variable is a count of the number of "other" households ($\neq i$) that live within close proximity (75 m) to site j.

(13) $SQKM_j$ This continuous variables indicates the area of site j in square-kilometers.[44]

The degree to which household i feels "unwelcome" collecting at site j may then be expressed as:

(14) $UNWELC_{ij}$ This variable is continuous between 0 and 1; with 0 representing sites that household i are most welcome to visit, and 1 representing sites household i is least welcome to visit. Therefore,
$UNWELC_{ij} = 0$ if $JUSTCLOSE_{ij} = 1$ or $AGFIELD_{ij} = 1$,
$UNWELC_{ij} = 1$ if $AGFIELD_{ij} = 2$,
or $UNWELC_{ij} = NUOHHJC_{ij} / SQKM_i$ (normalized between 0 and 1) if the site in close proximity to another household.[45]

Since the higher the degree of "unwelcomeness" the greater the institutional exclusivity "other" households have over a site, it is expected $UNWELC_{ij}$ will have a negative effect on the probability of household i choosing site j.

The second and third variables representing social norms that restrict which sites a household may visit are based on household i getting "upset" at other households from collecting at site j. Note that since it was felt that households would not admit to having "other" households get upset at them for collecting fuelwood at a particular site, data was collected on household i getting upset at other households. More specifically households in the survey were asked whether they would be upset if they saw someone from the

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[44] Measured on the same map that was used to measure distances to each site.
[45] Note that by constructing this spectrum as specified above, we are implicitly assuming that the people wishing to collect fuelwood at sites close to another household's field are equally unwelcome at that site which has the highest value of $NUOHHJC_{ij} / SQKM_i$, since in both of these situations, $OHHUNWELC_{ij} = 1$.

other side of the village collecting at site j, and whether they would be upset if they saw someone from another village collecting a site j.

The second variable representing social norms ($UPSETJ_{ij}$) is based on "insider" and "outsider" households. Insider households that seem to claim exclusive use of a site are upset if other outsider households use that site. Outsider households live in Jinga, but generally live some distance away from the site to which insiders lay claims. It was assumed that the degree to which an outsider household i is discouraged is positively related to the number of insider households that would get upset if they an outsider collecting at site j. The variable $UPSETJ_{ij}$ was constructed as follows:

(15) $UPSETJ_{ij}$ — If household i would be upset if they saw someone from the other side of the village collecting at site j, $UPSETJ_{ij} = 0$.
If household i would not get upset, $UPSETJ_{ij}$ = the number of households in the sample that would be upset if the saw someone from the other side of the village collecting at site j.

Since $UPSETJ_{ij}$ varies positively with the degree to which household i is discouraged from visiting site j, it is expected to have a negative effect on the probability of visiting site j.

The third variable representing social norms ($UPSETOV_{ij}$) is based on getting "upset" at households from outside Jinga village. It was felt that discouraging site visits of households from another village may make fuelwood collection "less crowded" at the site, and therefore increase the probability of household i visiting site j.

(16) $UPSETOV_{ij}$ — If household i would be upset if they saw someone from the another village collecting at site j $UPSETOV_{ij} = 1$,
if not $UPSETOV_{ij} = 0$.

While not specifically addressed in this study, these variables representing social norms are likely co-determined to some extent with distance. For example, the closer household i lives to a site the more likely they would be upset at someone from the other side of the village at the site. As mentioned in Chapter 2, this is an example of heterogeneity and social norms that create exclusivity being co-determined.

4.3.4 Social Norms that Encourage Collective Use of Fuelwood Resources

Fuelwood collection can involve interactions between households. In particular, women from different households talk amongst themselves about collecting fuelwood or accompany each other on collection trips. These interactions may simply represent opportunities for women to socialize, or they may also reflect institutions that encourage collective action between households for managing fuelwood at some sites as common property. Being aware of each other's actions may allow households to control excessive fuelwood collection. Also, in socializing amongst themselves, households may be exchanging information and advice in order to better "manage" fuelwood resources at particular sites.

It was difficult to come up with appropriate and straightforward questions in the household survey to inquire about social norms that represent collective action. If they do exist, these social norms are probably entrenched within subtle or subconscious behavior codes. The following variables were then constructed in an attempt to capture some of the social norms:

(17) $SPEAK_{ij}$ — If household i indicated that they would speak with another household about collecting fuelwood at site j, $SPEAK_{ij} = 1$, if not $SPEAK_{ij} = 0$.

(18) $ACCOMPANIED_{ij}$ — If household i indicated that they would be accompanied with someone from another household to collect fuelwood at site j $ACCOMPANIED_{ij} = 1$, if not $ACCOMPANIED_{ij} = 0$.

Speaking with another household ($SPEAK_{ij}$) may reflect social controls that prevent rent dissipation and increase site values, or it may simply reflect that households tend to speak more about sites they visit. Similarly, being accompanied by another household to a fuelwood site (*$ACCOMPANIED_{ij}$*) may reflect a social norm, or it may simply reflect that households enjoy the company of others travelling to some sites. Whether, these variables represent collective use of fuelwood resources and/or merely the chance to socialize, it is expected that each have a positive effect on the probability of household *i* visiting site *j*. However, it is beyond the scope of this study to be able to deduce to what extent each of these variables actually represent collective action for preventing rent dissipation.

4.3.5 Joint-Production Opportunities

The following binomial variables were constructed to represent joint-production activities household *i* may associate with collecting fuelwood at site *j*, or along route travelling to site *j*:[46]

- $FRUIT_{ij}$ – collecting fruits from indigenous trees.
- $HERB_{ij}$ – collecting medicinal plants.
- $ANIMAL_{ij}$ – trapping small animals to eat, such as mopane worms or small birds.
- $RELISH_{ij}$ – collecting wild vegetables or mushrooms.
- $FIBER_{ij}$ – collecting reeds, grass or bark for making household products.
- $FRIEND_{ij}$ – visiting a friend.
- $GARD_{ij}$ – stopping to check or work on the household garden plot or fields.

Using $FRUIT_{ij}$ as an example, each of these joint-production variables was constructed as:

(19) $FRUIT_{ij}$ If household *i*[47] associates collecting fruits with collecting fuelwood at site site *j*, $FRUIT_{ij} = 1$,
if not, $FRUIT_{ij} = 0$.

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[46] In the PRM background information, bathing and going to the village shops were also identified as joint-production opportunities (see Table 5 above). However, in the household survey these activities were only identified by a few households for one or two sites that were far away from their homestead. Therefore, bathing and stopping at the shops were not included in the model.

[47] Subscript *i* remains since joint-production opportunities for the same site may vary across households because they will be using different routes to access the same site.

It is expected that each of these joint-production variables has a positive effect on the probability of household *i* visiting site *j*, because each joint-production opportunity would seem to increase the household utility of visiting a particular site.

4.3.6 Fuelwood Species Availability

Data on the availability of individual fuelwood species is based on information compiled across households in Week 1 of the household survey. Households were asked for each trip to a particular site to list up to five species they had collected. In addition they were also asked to list up to five species they would have collected at each site in their choice set not necessarily visited during the survey period. A species was then considered "available" if any household had listed it for site *j*. Using *SPEC1* (*Combretum molle*) as an example,[48] species availability variables were constructed as follows:

(20) $SPEC1_j$ If any household in Week 1 of the survey collected (or would have collected) *SPEC1* at site *j*, $SPEC1_j = 1$,
if not $SPEC1_j = 0$.

(Repeated for $SPEC2_j$ to $SPEC36_j$.) Since species preference varies between households, the PRM background information gives no indication of what the expected effect the availability of each species will have of the probability of household *i* visiting site *j*.

4.3.7 Conditional Indirect Utility Function

Based on the RUM for site choice outlined in Chapter 3, and the above variables constructed to represent various site characteristics, the conditional indirect utility function for household *i* collecting at site *j* is specified as:[49]

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[48] See Appendix C for a list of 36 different tree species that were identified as being used for fuelwood.

[49] Unless socio-economic characteristics of the household are interacted with other terms in the household indirect utility function, they will drop out of the RUM since they are constant across all choices (Greene, 1993). In this study household cash income was the only socio-economic data collected for each household, and in the end interacting income with travel costs did not increase the explanatory power of the model, nor was the term significant (at the 10% level) in influencing site choice.

$$
\begin{aligned}
(21) \quad V_{ij} = \; & B_1(HHCALBUDG_i - CALORIES_{ij}) \\
& + B_2(DIFFICULTE_{ij}) + B_3(DIFFICULTMij) + B_4(AVAILL_j) \\
& + B_5(AVAILM_j) + B_6(UNWELC_{ij}) + B_7(UPSETJ_{ij}) + B_8(UPSETOV_{ij}) \\
& + B_9(SPEAK_{ij}) + B_{10}(ACCOMPANIED_{ij}) + B_{11}(FRUIT_{ij}) \\
& + B_{12}(HERB_{ij}) + B_{13}(ANIMAL_{ij}) + B_{14}(RELISH_{ij}) \\
& + B_{15}(FIBER_{ij}) + B_{16}(FRIEND_{ij}) + B_{17}(GARD_{ij}) \\
& + B_{18}(SPEC1_j) + \; \ldots.. \; + B_{53}(SPEC36_j)
\end{aligned}
$$

Table 9 summarizes the site characteristic variables, whether they effect institutional exclusivity and the expected signs for each of the coefficients in the above conditional indirect utility function.

Table 9: Variables Descriptions, Potential Effects on Institutional Exclusivity, and Expected Signs of the Coefficients in the Conditional Indirect Utility Function.

Variable	Variable Description	Potential Effect on Institutional Exclusivity (yes/no/?)	Expected Sign on the Coefficient*
$HHCALBUDG_i - CALORIES_{ij}$	The amount of calories left to expend on all other house production activities.	No	+
$DIFFICULTE_{ij}$	$DIFFICULTE_{ij}$ = 1 if difficulty of traveling and collecting fuelwood at site *j* is rated as "easy", = 0 otherwise.	No	+
DIFFICULTMij	$DIFFICULTM_{ij}$ = 1 if difficulty of traveling ans collecting fuelwood at site *j* is rated as "medium", = 0 otherwise.	No	+/-
$AVAILL_j$	$AVAILL_j$ = 1 if overall fuelwood availability is rated as low, = 0 if otherwise.	No	-
$AVAILM_j$	$AVAILM_j$ = 1 if overall fuelwood availability is rated as medium, = 0 if otherwise.	No	+/-
$UNWELC_{ij}$	The degree to which "other" households make household *i* feel "unwelcome" for collecting at site *j*.	Yes	-
$UPSETJ_{ij}$	The number of households that are 'upset' at seeing a household from the other side of Jinga collecting fuelwood at site *j*, or 0 is household *i* would also be upset.	Yes	-
$UPSETOV_{ij}$	$UPSETOV_{ij}$ = 1 if 'upset' at seeing a household from another village collecting fuelwood at site *j*, = 0 if otherwise.	Yes	+
$SPEAK_{ij}$	$SPEAK_{ij}$ = 1 if associate speaking with another household about collecting fuelwood at site *j*, = 0 if otherwise.	Yes	+
$ACCOMPANIED_{ij}$	$ACCOMPANIED_{ij}$ = 1 if associate being accompanied with someone from another household while collecting fuelwood at site *j*, = 0 if otherwise.	Yes	+
$FRUIT_{ij}$	$FRUIT_{ij}$ = 1 if associate collecting fruits at or on route to site *j*, = 0 if otherwise.	No	+
$HERB_{ij}$	$HERB_{ij}$ = 1 if associate collecting medicinal plants at or on route to site *j*, = 0 if otherwise.	No	+
$ANIMAL_{ij}$	$ANIMAL_{ij}$ = 1 if associate collecting small animals at or on route to site *j*, = 0 if otherwise.	No	+
$RELISH_{ij}$	$RELISH_{ij}$ = 1 if associated collecting vegetables or mushrooms at or on route to site *j*, =0 if otherwise.	No	+
$FIBER_{ij}$	$FIBER_{ij}$ = 1 if associate collecting reeds, grass or bark at or on route to site *j*, = 0 if otherwise.	No	+
$FRIEND_{ij}$	*FRIENDij* = 1 if associate visiting a friend on route to site *j*, =0 if otherwise.	No	+
$GARD_{ij}$	$GARD_{ij}$ = 1 if associate stopping at the household garden plot or agricultural field on route to site *j*, = 0 if otherwise.	No	+
$SPEC1_j$ ... $SPEC36_j$	$SPEC1_j$ ... $SPEC36_j$ = 1 if associate collecting a respective fuelwood species at site *j*, =0 if otherwise.	No	+/-

* - +/- means the expected sign on the coefficient is indeterminate.

5.0 Results

5.1 Summary Statistics

Summary statistics in Table 10 are presented for selected variables for the 94 households for which complete information was collected in the household survey. Comparing mean values for Average Distance to Sites Visited (0.49 km) and Average Distance to Sites in the Choice Set (0.84 km) suggests that households favor sites closer to the homestead. In terms of the "difficulty" of travelling and collecting at a site, visits are fairly evenly distributed between sites with "easy", "moderate" or "hard" difficulty ratings. Visits are also fairly evenly distributed between sites with overall fuelwood availability ratings of "low", "medium" or "high".

Table 10: Summary Statistics on Survey Data*

Item	Mean	Std. Dev.	Min.	Max.
Number of Sites in a Household's Choice Set	10.8	2.90	5	16
Total Trips to Collect Fuelwood per Household Over Three Weeks	8.7	3.87	2	17
Average Distance (km) to Sites in the Choice Set	0.84	0.185	0.53	2
Average Distance (km) to Sites Visited	0.49	0.24	0.08	2
% of Visits where $DIFFICULTL_{ij}$ =1	0.316	0.354	0	1
% of Visits where $DIFFICULTM_{ij}$ =1	0.360	0.367	0	1
% of Visits where $AVAILL_j$ = 1	0.378	0.343	0	1
% of Visits where $AVAILM_j$ =1	0.264	0.344	0	1
% of Visits where $AGFIELD_{ij}$ = 2	0.0	0.0	0	0
% of Visits where $NUOHHJC_{ij} > 0$	0.246	0.346	0	1
% of Visits where $UPSETJ_{ij} > 1$	0.673	0.392	0	1
% of Visits where $UPSETOV_{ij}$ = 1	0.574	0.446	0	1
% of Visits where $SPEAK_{ij}$ = 1	0.542	0.444	0	1
% of Visits where $ACCOMPANIED_{ij}$ =1	0.465	0.410	0	1
% of Visits where $FRUIT_{ij}$ =1	0.855	0.289	0	1
% of Visits where $HERB_{ij}$ =1	0.256	0.090	0	1
% of Visits where $ANIMAL_{ij}$ = 1	0.138	0.311	0	1
% of Visits where $RELISH_{ij}$ =1	0.155	0.321	0	1
% of Visits where $FIBER_{ij}$ = 1	0.028	0.149	0	1
% of Visits where $FRIEND_{ij}$ = 1	0.125	0.287	0	1
% of Visits where $GARD_{ij}$ = 1	0.149	0.282	0	1

* Mean and Standard Deviation are based the complete data collected for 94 households. For example, mean average distance is the mean of the average distance each household traveled to sites to collect fuelwood.

Some evidence of social norms affecting site choice is also evident in Table 10. A value of 0.0 at sites where $AGFIELD_{ij} = 2$ suggests that having to ask permission to collect fuelwood in close proximity to someone else's field discourages fuelwood collection at these sites. Also, while 54% of sites have at least one household living in close proximity to a site ($NUOHHJC_{ij} > 0$), a low percentage of trips to these sites (24.7%) suggests that having to ask other households permission to collect in close proximity to their homestead is also somewhat effective at deterring fuelwood collection at these sites.

Regarding joint-production opportunities that affect site choice, there is wide variation in terms of visited sites that are associated with a particular joint-production opportunity. For example, the opportunity to collect fruits is associated with a high percentage of sites visited (85.5%) and the opportunity to collect fiber is associated with a low percentage of sites visited (2.8%).

Although fuelwood species are not listed in Table 10, *Combretum molle* ($SPEC1_{ij}$) and *Colophosperum mopane* ($SPEC2_{ij}$) are available at almost every site visited, while fuelwood species $SPEC16_{ij}$ to $SPEC36_{ij}$ are only available at only one or two sites. All of these 24 fuelwood species were omitted from the model due to very limited variation in availability between sites visited.[50]

5.2 Estimation Results

Estimated coefficients for the RUM are presented in Table 11. A Log Likelihood Function value of –1152.488 and a R^2 value of .49554 suggest the model has fairly significant explanatory power. Furthermore, for those variables with positive or negative expected signs on the coefficient (excluding species variables - see Table 9 in Chapter 4), all but 4 are significant at the 10% level; and of those variables that are significant, all but 1 have the sign of their coefficient as expected.

The first group of variables is associated with travel and collection costs. The travel cost variable ($HHCALBUDG_i - CALORIES_{ij}$) is significant with a positive coefficient. Correspondingly, travel costs ($CALORIES_{ij}$) have a negative effect on the

[50] Variables must have a certain degree of variation between sites visited so the Hessian may be inverted to estimate the RUM using maximum likelihood estimation.

probability of visiting a site (since $HHCALBUDG_i$ was a constant in the model). The significance of travel costs suggests that heterogeneity in collection costs among households are potentially important in affecting fuelwood rents. Also reflecting travel costs, an "easy" difficulty rating ($DIFFICULTE_{ij}$) is significant and has a positive coefficient. Also, "low" overall fuelwood availability ($AVAILL_j$) is significant and has a negative coefficient.

Table 11: Estimation Results

Variable:	Coefficient:	Estimate:	T – ratio:
$HHCALBUDG_I - CALORIES_{ij}$	B_1	0.0035	16.472**
$DIFFICULTE_{ij}$	B_2	0.4002	2.809**
$DIFFICULTMij$	B_3	0.1095	0.951
$AVAILL_j$	B_9	-0.8474	-5.409**
$AVAILM_j$	B_{10}	-1.2531	-6.629**
$UNWELC_{ij}$	B_4	-5.3730	-13.718**
$UPSETJ_{ij}$	B_5	-0.0283	-3.611**
$UPSETOV_{ij}$	B_6	0.1184	0.822
$SPEAK_{ij}$	B_7	1.0350	7.764**
$ACCOMPANIED_{ij}$	B_8	-0.5373	-3.829**
$FRUIT_{ij}$	B_{11}	0.2574	1.891*
$HERB_{ij}$	B_{12}	0.3584	1.546
$ANIMAL_{ij}$	B_{13}	0.9287	4.601**
$RELISH_{ij}$	B_{14}	0.7617	3.483**
$FIBER_{ij}$	B_{15}	0.9164	2.563**
$FRIEND_{ij}$	B_{16}	0.0810	0.435
$GARD_{ij}$	B_{17}	0.0945	0.537
$SPEC3_j$	B_{21}	2.350	1.999**
$SPEC4_j$	B_{22}	-3.0081	-2.271**
$SPEC5_j$	B_{23}	-0.6462	-0.738
$SPEC6_j$	B_{24}	5.1726	1.791**
$SPEC7_j$	B_{25}	-0.0384	0.040
$SPEC8_j$	B_{26}	-0.5681	-0.680
$SPEC9_j$	B_{27}	2.4158	2.371**
$SPEC10_j$	B_{28}	-0.3609	-0.653
$SPEC11_j$	B_{29}	-0.2473	-0.647
$SPEC12_j$	B_{30}	-2.3452	-1.197
$SPEC13_j$	B_{31}	1.0096	4.328**
$SPEC14_j$	B_{32}	-0.1410	-0.533
$SPEC15_j$	B_{33}	-0.8832	-1.903*
Log Likelihood Function		-1152.488	
R^2		.49554	

* - Significant at a 10% level of significance.
** - Significant at a 5% level of significance.

There are a number of variables dealing with social norms in the second group in Table 11. Feeling "unwelcome" because other households have some degree of exclusivity over a site (*UNWELC*$_{ij}$), and being discouraged as an outsider from visiting sites based on other households getting "upset" (*UPSETJij*), are significant and both have negative coefficients. These results suggest that social norms are significant factors in influencing fuelwood collection behavior. Getting upset at someone from another village (*UPSETOVij*) is not significant; perhaps because this social norm is not effective at reducing crowding at sites. Speaking (*SPEAK*$_{ij}$) about collecting fuelwood at site *j* with another household is significant, and, as expected, the coefficient is positive. Accordingly, there is a higher probability of visiting a "spoken of site", either because social controls associated with discussing sites prevent rent dissipation and increase site values, and/or merely because households tend to speak more about sites they visit. Another variable identified in Chapter 4 that could involve social norms and/or joint production opportunities, is being accompanied by one or more persons to a fuelwood site (*ACCOMPANIED*$_{ij}$). It was thought to potentially control fuelwood collection behavior and/or provide the enjoyment of company. However, contrary to expectations, the sign on this significant variable was negative. A negative coefficient may be explained by a high correlation between being accompanied and travel distances, or because households simply prefer to be alone when collecting fuelwood.[51] Since it would be very difficult to "covertly" collect fuelwood in Jinga, it is unlikely that a negative coefficient on *ACCOMPANIED*$_{ij}$ implies that a household is more likely to go to a site where they are not being monitored.

A third group of variables is associated with joint production opportunities of sites. Four of the 7 joint production activities are significant and positive in influencing site choice: opportunities to collect fruits (*FRUIT*$_{ij}$); small animals (*ANIMAL*$_{ij}$); relish (*RELISH*$_{ij}$); and fiber (*FIBER*$_{ij}$).

The final group of variables contains fuelwood species. Six out of thirteen fuelwood species in the model are significant; some with positive and some with negative

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[51] Hatton MacDonald *et al.* (1998) found a variable similar to (*ACCOMPANIED*$_{ij}$) to be positive and significant.

coefficients. Positive coefficients are associated with preferred species, while negative coefficients are associated with less desirable species.

5.3 Welfare Measures

As outlined in Chapter 3, welfare measures of compensating variation may be used to calculate the effects of removing each site separately from a household's choice set, which are then used as estimates of site rents. Sites rents for the 47 different fuelwood collection sites are presented in Table 12. Since travel costs are measured by calories, rents are expressed in terms of calories per trip. Total sites rents are calculated by summing individual site rents across every household with site j in their choice set (with n = the number of households with that site in their choice set), which includes multi-purpose rents captured at each site. Total fuelwood rents are then calculated as total site rents minus the welfare effects of removing all joint-production opportunities. A mean of 746 calories/trip for total site rents and 502 calories/trip for total fuelwood rents suggests that for the average site, one-third of the rents captured on fuelwood collection trips come from joint production opportunities. Since by definition removing any site in a household's choice set is associated with some negative level of compensating variation, high total rents or total fuelwood rents for a site are partly explained by many households having that site in their choice set.

Table 12: Site Rents Associated with Fuelwood Collection (calories/trip)

Site	Total Site Rents	Fuelwood Rents		
		Total Rents	Average Household Rents	(*n* =)*
1	2667	1878	30.8	(61)
2	122	85	7.1	(12)
3	1670	810	22.5	(36)
4	5331	3792	54.2	(70)
5	692	594	22.0	(27)
6	1558	1214	25.3	(48)
7	3520	1972	44.8	(44)
8	984	573	11.5	(50)
9	298	148	11.4	(13)
10	1873	1559	28.9	(54)
11	539	309	17.2	(18)
12	2189	1342	67.1	(20)
13	39	29	2.9	(10)
14	439	358	19.9	(18)
15	796	665	44.3	(15)
16	1520	892	63.7	(14)
17	1172	681	56.7	(12)
18	2803	1809	44.1	(41)
19	90	67	7.5	(9)
20	375	231	11.5	(20)
21	690	354	29.5	(12)
22	516	203	33.8	(6)
23	243	240	5.7	(42)
24	142	65	3.8	(17)
25	64	32	4.0	(8)
26	219	170	7.1	(24)
27	268	228	5.7	(40)
28	472	346	18.2	(19)
29	965	842	210.6	(4)
30	287	237	59.4	(4)
31	14	14	14.2	(1)
32	156	128	127.7	(1)
33	21	16	3.3	(5)
34	122	98	98.3	(1)
35	102	72	12.1	(6)
36	8	4	2.2	(2)
37	145	118	118.1	(1)
38	12	4	3.1	(2)
39	38	29	13.2	(6)
40	248	79	39.6	(2)
41	224	88	87.9	(1)
42	362	315	7.5	(42)
43	239	189	6.1	(31)
44	160	126	3.0	(42)
45	450	364	9.3	(39)
46	81	64	1.6	(39)
47	162	162	5.1	(32)
Mean:	746.6	502.0	32.2	(21.3)

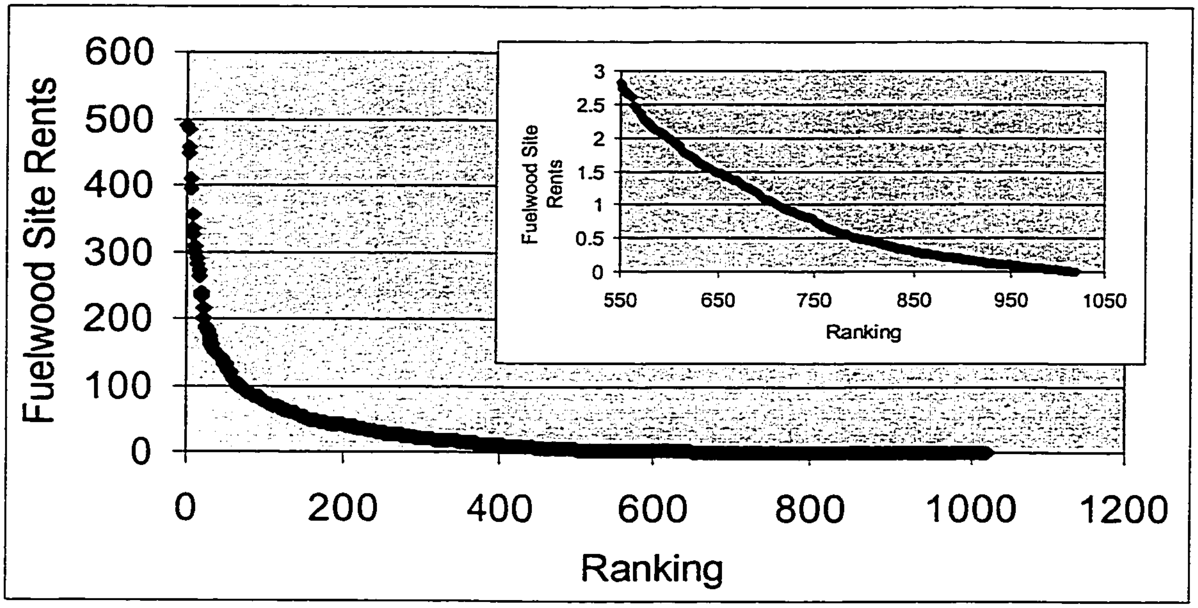
* *n* equals the number of households with the respective site in their choice set.

Values in table 12 also indicate that individual household welfare losses associated with some sites can be quite large despite the large number of substitute sites available in the village. In one case, average household fuelwood rents are greater than 200 calories per trip. If the average daily consumption of Zimbabwean women is 2000 calories per day (FAO, 1996), for the average person collecting fuelwood at this site these rents (per trip) represents 10% of their daily caloric intake.

One key feature of the results in Table 12 is the variation in the average household rents per trip among sites. In order to view this variation more closely, Figure 1 disaggregates average fuelwood rents in Table 12, with a distribution of all individual household rents per site, for every site, ordered from largest to smallest. An inset in the figure shows the right hand portion of the curve on a larger scale.

Although the welfare results in Table 12 and Figure 1 represent a static "snapshot" in time, derived from using a static RUM, results of the model may provide insight into the dynamics of rent dissipation. Following the Cheung (1970) model, searching for rents in an open access situation would, over time, lead to equi-marginal rents among sites. That is, as part of the rent dissipating process, sites with larger rents would attract more extraction, and homogeneous households would reduce these rents to the level of rent available at other sites. Accordingly, if rent-dissipating behavior amongst homogeneous households were indeed happening in the absence of any exclusivity, we would expect over time to see some level of uniformity among fuelwood site rents. The fact that we see great variation among average site rental values suggests that this process is not taking place. Indeed, even in the lower reaches of the distribution of site rents shown in the inset of Figure 1, rent differentiation is continually evident. Therefore, it appears that social norms and heterogeneous costs are preventing this process of rent-dissipation.

Figure 1: Ranking of Household Fuelwood Site Rents (for every household and every site in their choice set).



The significance of the variables in the RUM also suggests that social norms and heterogeneity are both contributing towards creating fuelwood rents. In Table 13 separate welfare measures for removing the significant site characteristics that represent heterogeneity ($CALORIES_{ij}$)[52] and exclusivity ($UNWELC_{ij}$ and $UPSETJ_{ij}$) are presented. For each household, compensating variation was calculated based on removing the respective site characteristic from all sites in their choice set. The positive values of compensating variation for removing $CALORIES_{ij}$ indicate that households would be better off if travel costs were removed. These positive welfare measures are as expected, since the estimation results in Table 11 showed that travel costs have a negative effect on the utility associated with visiting site *j*. Similarly, positive values of compensating variation for removing $UNWELC_{ij}$ and $UPSETJ_{ij}$ indicate that households would be better off if social norms did not restrict them from accessing some sites. Although these results may, at first glance, seem counter-intuitive, the negative welfare measures are also as expected, because Table 11 shows that making household *i* feel "unwelcome" or other households being "upset", has a negative effect on the utility of visiting a site *j*. The

[52] The difficulty rating $DIFFICULTE_{ij}$ is not included as a heterogeneity factor because it does not specifically capture differences in travel costs between households for the same site that are not already captured with $CALORIES_{ij}$.

counter-intuitive nature of these results may be explained by remembering that the RUM represents a static snapshot of welfare effects, and as such does not pick up benefits in dynamic settings. In a partial equilibrium individuals would benefit in the short term from being free of social norms, but in the longer term the resource would deteriorate with rent-dissipating behavior. Perhaps the fact that households are willing to forgo short-term gains that could be realized from eliminating social norms, shows that they recognize the longer term gains that are realized from self-control social institutions.

Table 13 also suggests the influence of $CALORIES_{ij}$ as a proxy for heterogeneity is larger than the influence of either $UNWELC_{ij}$ and $UPSETJ_{ij}$ as social norms for influencing rent levels. Note, however, that it would not be prudent to conclude that heterogeneity plays a larger role in preventing rent dissipation than do social norms. The two social norm variables in the model are likely not exhaustive of the large range of potential social norms that could be influencing fuelwood collection behavior and values. Similarly, as discussed above $CALORIES_{ij}$ probably does not represent all of the heterogeneity between households with respect to fuelwood collection. Accordingly, it is not possible to conclude that either heterogeneity or social norms play a larger role in preventing the tragedy of the commons. From our results it is only possible to suggest that in Jinga heterogeneity represented in calories ($CALORIES_{ij}$) is playing a larger role than the social norms ($UNWELC_{ij}$ and $UPSETJ_{ij}$) represented in the model. Furthermore, if the results in Table 13 were dissaggregated between households and sites, for some sites for some households the welfare effect of removing either (or both) social norms is greater than the effect of reducing travel costs to zero.

Table 13: Welfare Measures for Separately Removing Travel Costs and Institutions Influencing Site Choice as Site Characteristics for All Sites.

Site Characteristic	Household Compensating Variation (calories/trip) For Removing the Site Characteristic for All Sites		
	Mean*	Minimum*	Maximum*
$CALORIES_{ij}$	444.9**	115.2	747.9
$UNWELC_{ij}$	185.8	0.2	629.7
$UPSETJ_{ij}$	39.7	0	157.7

* Mean, minimum and maximum household compensating variation for all households in the model.

** Note: Positive values for compensating variation are interpreted as the amount of calories/trip a household is better-off after the change.

6.0 Conclusions

6.1 Positive Fuelwood Rents

Welfare measures in Table 12 in Chapter 5 suggest that there are positive fuelwood rents associated with every woodland collection site in the model. By themselves these results are not surprising. The 47 different sites in the model were identified based on being used by at least one household within the sample; and unless households were finally exhausting fuelwood rents at the time of this study, which is unlikely, visits to a site suggest some level of net benefits are being realized. Total fuelwood rents for many sites are perhaps even larger than the amount suggested by the welfare measures, because several households outside the sample use sites identified in the model, especially those sites in villages adjacent to Jinga. There may also be sites within Jinga that were not identified, and thus not included in the model; sites that perhaps no household visits because they are either too remote or too heavily disturbed. These sites may still be associated with potential fuelwood rents, but small enough that another site is always chosen. However, with confirmation of Campbell *et al.*'s (1997) finding of overall positive fuelwood rents in Jinga, the focus of this study is on factors preventing total rent dissipation at every site in the model.

Although village rules dictate that all fuelwood collection sites are open-access (Kundhlande and Luckert, 1998), theory suggests positive fuelwood rents may be partially explained by the social norms and heterogeneous travel costs that were found to have a significant influence on site choice. Furthermore, substantial differences in average fuelwood rents between sites also suggest that social norms and heterogeneity are preventing rent dissipation from occurring according to some equimarginal rule between sites. For example, one of the effects of social norms is that households seem to have *de facto* individual exclusivity over sites in close proximity to their agricultural fields. Also, while welfare measures indicate that in the short term households would be individually better-off if some social norms were removed, adherence to these social norms suggests collective restraint is being exercised in order to prevent longer term rent dissipation.

Welfare measures also suggest that in general travel costs have a greater influence on site choice than the social norms identified in this study. While this may suggest that heterogeneous travel costs are an important influence in preventing total rent dissipation, it does not necessarily mean that heterogeneity has a greater influence on fuelwood rents than social norms. Still, because of the importance of heterogeneity in influencing rents, policy makers should be aware that traditional or local institutions might only be partially responsible for influencing value of woodland resources. Unfortunately heterogeneity is not a very direct instrument for policy makers to use in increasing rents.

6.2 Is the Tragedy of the Commons Possible?

Positive fuelwood rents for all woodland collection sites indicate that overall the tragedy-of-the-commons outcome of total rent dissipation has been averted for fuelwood resources in Jinga. There may be sites no longer used, and at some sites rents are perhaps totally dissipated for the marginal household[53], but it was found that every household associates positive levels of rents with at least some sites. Perhaps this is not surprising. According to the Cheung (1970) model, open-access and homogeneity are two separate and necessary conditions for total rent dissipation to occur for a CPR. In fact, the results of this study suggest neither of these two conditions are satisfied. Indeed fuelwood resources in Jinga are not entirely open-access with the existence of social norms that create some degree of exclusivity. But even if common pool fuelwood resources in Jinga were open-access, heterogeneity in terms of travel costs would prevent total rent dissipation.

Perhaps the relevant question is whether both heterogeneity and social norms could be reduced to zero to make total rent dissipation a real possibility? Let us examine these two factors separately. First, regarding social norms, it may be possible that the erosion of social norms will render fuelwood resources open-access in the future. However, a counter argument might be that the erosion of institutions, such as in Zimbabwe[54], has lead to the persistence of social norms between households for managing common pool woodland resources. Therefore, social norms may be a means to maintain exclusivity in the face of rules from more formal institutions being undermined

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[53] However, the specification of the household indirect utility function and limiting choice sets to those sites within a certain radius of the homestead precluded these "valueless" sites for a household from being identified.
[54] As discussed by Campbell *et al.* (2000).

or disrupted. Second, regarding heterogeneity, it is difficult to conceive all households as being homogeneous in terms of fuelwood production. For example, every household would have to live in the exact same location in order to be homogeneous in terms of travelling to sites and collecting fuelwood by the headload. Therefore, based on these two factors, the tragedy-of-the-commons in terms of total rent dissipation does not just seem unlikely, but also seems impossible.

This notion of the tragedy-of-the-commons being impossible reduces the open-access/total rent dissipation outcome to a conceptual extreme on the exclusivity/rent dissipation spectrum. Clearly heterogeneity between households in terms of fuelwood production exists, and a complete void of social norms is improbable. Therefore, the question is not how to prevent total rent dissipation, but to attempt to find a solution that maximizes available rent. In search of a solution, the effects of heterogeneity and institutions are likely to both be important. However, whereas institutions may be altered with changes in policy, heterogeneity is more of a contextual feature that partially defines the environment within which policy changes should be considered.

Also, since heterogeneity and social norms may exist simultaneously, forgetting the role of one undermines the perception of how the other is allowing rents to be captured. For example, one should not assume that the maximum distance a household is willing to travel to a fuelwood collection site is the result of institutions reserving sites beyond this distance for other households. The reason a household does not travel beyond a certain distance may be that the costs for that household, but not necessarily for other households, exceed the benefits of a headload of fuelwood.

6.3 Future Research

A number of areas for future research are prompted by this study. First, since rent dissipation may be best described as happening over time, an area for future research may be to develop and empirically test dynamic models for investigating the extent to which rents are being efficiently captured. In terms of fuelwood collection, this might involve incorporating data on the natural growth rates of fuelwood stocks, depletion rates, institutional change, and perhaps changes in the heterogeneity of fuelwood collection costs between households. Also, further research in Jinga may reveal additional sites where fuelwood stocks have been depleted to the point where no household bothers to visit the site. A dynamic model, for example, may then be used to investigate at what point households stop using a site and to what extent the rents from using the site were efficiently captured. Or perhaps, in a different village, where fuelwood substitutes are more common, a dynamic model might be used to model total rent dissipation according to the "price level" of collecting fuelwood where households switch over to fuelwood substitutes such as paraffin. Dynamic models may also be used to investigate changes to local or traditional institutions and their effectiveness in managing woodland resources, or for investigating how rents can be captured beyond some "threshold" level of exploitation where ultimately the resource will collapse from overuse.

Second, including spatial effects, in a dynamic or static model, would allow simulations to be run for investigating factors such as the effects of heterogeneity on fuelwood rents when the location or number of households is changed. Simulations such as these might be of use to policy makers, particularly in Zimbabwe, where land reform since independence has been causing substantial demographic changes in the communal lands where woodlands are traditionally managed as CPRs.

Third, researchers could develop models that account for endogeneities between institutions and heterogeneity. For example, there may be a social norm that allows a household to exclude others from accessing a fuelwood collection site that is close to its homestead; a social norm that may be determined in part by heterogeneity because it could be a function of all other homesteads being situated a lot further away from the site. This endogeneity may arise because heterogeneity has prevented rent dissipation, and thus simultaneously encouraged institutions to emerge in order to preserve such value. Similarly, Pearse (1988) noted that high resource values are associated with more complex norms.

A fourth area for future research has to do with the inherent difficulties of collecting data and specifying social norms or informal rules in a household model. This study serves as a "first-attempt" to specify social norms between households in a site choice model for fuelwood collection. Among the challenges, especially for a researcher from outside Zimbabwe, were identifying social norms that may not be consciously recognized by villagers; separating social norms that are institutions for restricting fuelwood collection from social norms that underlie other village activities, such as socializing between households; and specifying variables that may directly represent or be a proxy for social norms in a household model. More research is certainly required to improve how models can represent social norms.

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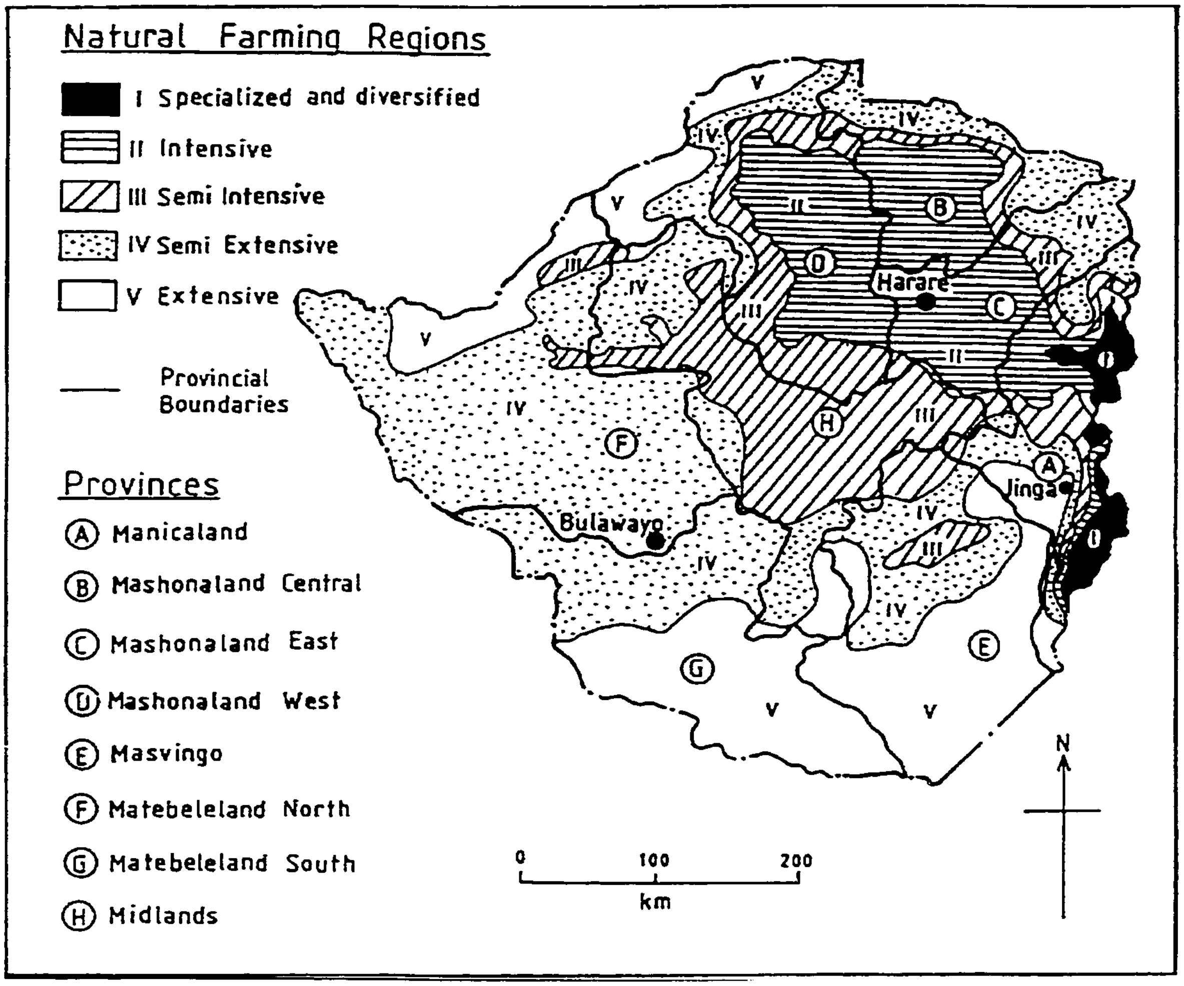
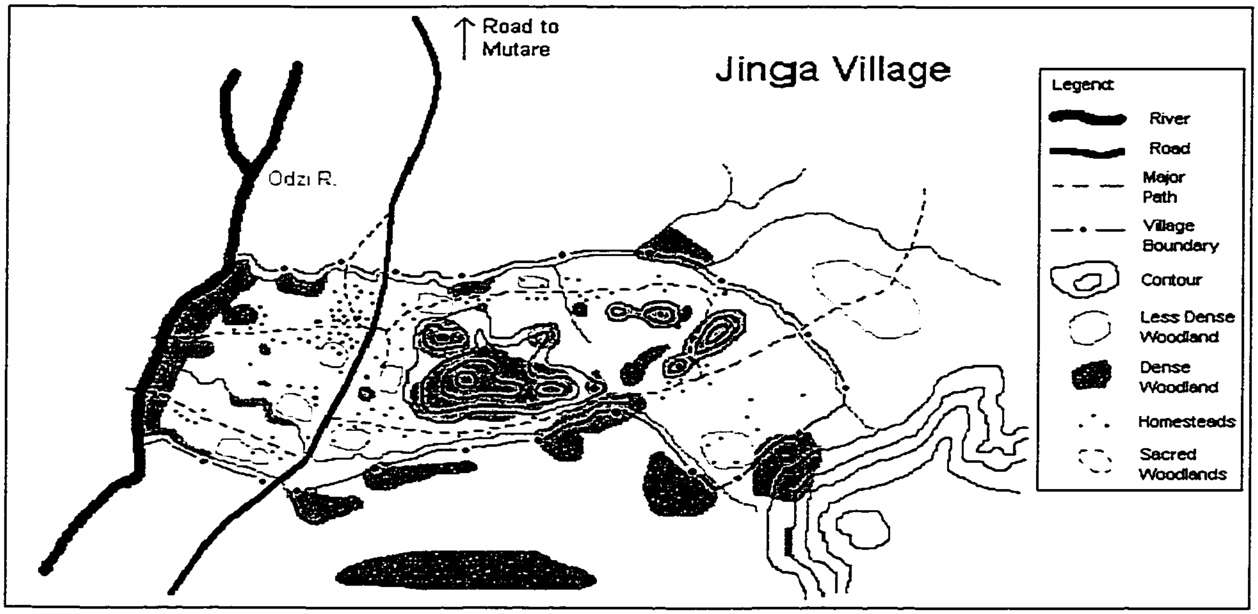
Appendix A. Map of Zimbabwe



Appendix B. Map of Jinga Village



Appendix C. Tree Species Used For Fuelwood.

Species	Local Name	Variable
Combretum molle	Mugodo	$SPEC1_i$
Colophosperum mopane	Musharu	$SPEC2_i$
Dalbergia melanoxylon	Muhweti	$SPEC3_i$
Julbernadia globiflora	Mutondo	$SPEC4_i$
Brachystegia spiciformis	Musasa	$SPEC5_i$
Brachystegia glauceseus	Muunze	$SPEC6_i$
Afzelia quanzensis	Mukamba	$SPEC7_i$
Strychnos madagascariensis	Mukwakwa	$SPEC8_i$
Terminalia sericea	Mususu	$SPEC9_i$
Diospyros quiloensis	Mukukuti	$SPEC10_i$
Cassia abreviata	Muremberembe	$SPEC11_i$
Acacia nilotica	Muguvhungu	$SPEC12_i$
Dichrostachys cinera	Mupanagara	$SPEC13_i$
Berchmia discolor	Munyii	$SPEC14_i$
Combretum heroense	Murowamhuru	$SPEC15_i$
Sysygium guineese	Muhute	$SPEC16_i$
Ximenia caffra	Munhengeni	$SPEC17_i$
Diospyros mespiliformis	Mushumba	$SPEC18_i$
Azanza garckeana	Mutohwe	$SPEC19_i$
Ficus spp	Mutsamvu	$SPEC20_i$
Bauhinia thoningii	Musekesa	$SPEC21_i$
Ficus capensis	Muonde	$SPEC22_i$
Grewia inaequilatera	Mutezwa	$SPEC23_i$
Kirkia acuminata	Mutuwa	$SPEC24_i$
Acacia tortilis	Muungu	$SPEC25_i$
Sclerocarya birrea	Mupfura	$SPEC26_i$
Kigelia africana	Mubvee	$SPEC27_i$
Hyphaene benguellensi	Murara	$SPEC28_i$
Uapaca kirkiana	Mushanje	$SPEC29_i$
Zizyphus mucronata	Muchecheni	$SPEC30_i$
Afzelia quanzensis	Mukumbangu	$SPEC31_i$
Syzgium cardatum	Mododdo	$SPEC32_i$
Garcinia huillensi	Mutunduru	$SPEC33_i$
Securinega virosa	Musosoti	$SPEC34_i$
Lonchocarpus capassa	Mupanda	$SPEC35_i$
Flacortia indica	Mundude	$SPEC36_i$

Appendix D. Household Survey

Household Firewood Collection Survey
Jinga Village - May 1999 - Week 1

Introduction:

- Greetings.
- A survey to learn about the places you collect firewood.
- Information to help a student - Larry Hegan - from the University of Alberta, Canada, working with the University of Zimbabwe - Answering these questions will also help the people of Jinga to understand more about firewood.
- Individual responses are confidential.
- Two visits will occur.
- Village leaders have given permission for this study.
- Participation is voluntary.

Household ID # ____________________
Date Begun ______________ Date Completed __________________
Approximate Start Time of Survey ___________________

Certification:
I certify on my honor that this interview, according to the agreement I have made as an enumerator, will be conducted honestly and completely.

____
Printed Name of Enumerator

________________________ _____________
Signature of Enumerator Date Completed

Section 1.

1. Name or describe all the **different** areas or places that your household might collect firewood from? *Circle each place the respondent indicates and if applicable write down the name of a place close to the homestead (5-100m) or the names of any 'other' places. Together the different places identified are the respondent's 'choice set'.*

1. Close to the homestead *(5-100m)*: __________________
2. Site A - Chinyamatede Mt.
3. Site B - Hapare For.
4. Site C - Ngungungu Mt.
5. Site D - Chinyamupoma Mt.
6. Site E - Nematowe Mt.
7. Site F - Chiire R.
8. Site G - Odzi R.
9. Site H - Murare R.
10. Site I - Chitakanga Strm.
11. Site J - Chaseyama Mt.
12. Site K - Chisamba Strm.
13. Site L - Nemuntenzi For.
14. Site M - Zongo For.
15. Site N - Mukorahwa Strm.

Other-A: ______________________________________
Other-B: ______________________________________
Other-C: ______________________________________

2. How long are you normally away from home while collecting firewood from each of these places? *Write the amount of time in hours and minutes for each place in their choice set.*

Places:	Time:
1. Close to homestead: ______	______
2. Site A - Chinyamatede Mt.	______
3. Site B - Hapare For.	______
4. Site C - Ngungungu Mt.	______
5. Site D - Chinyamupoma Mt.	______
6. Site E - Nematowe Mt.	______
7. Site F - Chiire R.	______
8. Site G - Odzi R.	______
9. Site H - Murare R.	______
10. Site I - Chitakanga Strm.	______
11. Site J - Chaseyama Mt.	______
12. Site K - Chisamba Strm.	______
13. Site L - Nemuntenzi For.	______
14. Site M - Zongo For.	______
15. Site N - Mukorahwa Strm.	______
Other-A: ______	______
Other-B: ______	______
Other-C: ______	______

3. Based on **all** places that firewood is available, how would you rate the difficulty of traveling to and collecting firewood at ______? Easy, Moderate, or Difficult? *(Rating: 1-Easy, 2-Moderate, 3-Difficult, 9-Don't Know) Ask this question separately for each place in their choice set.*

Places:	Rating:
1. Close to homestead: ______	______
2. Site A - Chinyamatede Mt.	______
3. Site B - Hapare For.	______
4. Site C - Ngungungu Mt.	______
5. Site D - Chinyamupoma Mt.	______
6. Site E - Nematowe Mt.	______
7. Site F - Chiire R.	______
8. Site G - Odzi R.	______
9. Site H - Murare R.	______
10. Site I - Chitakanga Strm.	______
11. Site J - Chaseyama Mt.	______
12. Site K - Chisamba Strm.	______
13. Site L - Nemuntenzi For.	______
14. Site M - Zongo For.	______
15. Site N - Mukorahwa Strm.	______
Other-A: ______	______
Other-B: ______	______
Other-C: ______	______

4. At ______________ *(place)* what kinds of trees do you collect pieces of for firewood? *Ask this question for each place in their choice set and write down the **first five** (or less) kinds of trees that are named.*

Places: Species:

1. Close to homestead: ____________ ____________________
____
2. Site A - Chinyamatede Mt. ____________________
____
3. Site B - Hapare For. ____________________
____
4. Site C - Ngungungu Mt. ____________________
____
5. Site D - Chinyamupoma Mt. ____________________
____
6. Site E - Nematowe Mt. ____________________
____
7. Site F - Chiire R. ____________________
____
8. Site G - Odzi R. ____________________
____
9. Site H - Murare R. ____________________
____
10. Site I - Chitakanga Strm. ____________________
____
11. Site J - Chaseyama Mt. ____________________
____
12. Site K - Chisamba Strm. ____________________
____
13. Site L - Nemuntenzi For. ____________________
____
14. Site M - Zongo For. ____________________
____
15. Site N - Mukorahwa Strm. ____________________
____

Other-A: ________________ ____________________
____

Other-B: ________________ ____________________
____

Other-C: ________________ ____________________
____

5. At these places, or along the way there, or on the way back home; there may be some other pleasant or useful things that you usually do or collected. For example there may be some fruits, medicines or other useful plants, or small animals that you collect. Or you might be able to stop at your garden or visit a friend. *Put an X (or write down any 'other' activity) down for the activities indicated to occur when away from home collecting firewood for each place in their choice set - or a "-" for not..*

Places	Fruits	Medic's	Garden	Relish	Friend	Animals	Other
1. Hmst							
2. S-A							
3. S-B							
4. S-C							
5. S-D							
6. S-E							
7. S-F							
8. S-G							
9. S-H							
10. S-I							
11. S-J							
12. S-K							
13. S-L							
14. S-M							
15. S- N							
O-A							
O-B							
O-C							

Section 2.

6. How many separate trips to collect firewood, used by **your** household, collected in any way, did members from your household make during the last seven days? ____________

7. On which days of the week did these trips occur? *Only record the last seven trips, starting with the least recent of the seven..*

Trip #1 ____________ Trip #5 ____________

Trip #2 ____________ Trip #6 ____________

Trip #3 ____________ Trip #7 ____________

Trip #4 ____________

Trip # 1 (repeated for Trips 2 –7) **Collected on :**
____________ ***(day of the week)***

8. Where did you go to collect firewood on **this trip only**?*: Circle the place the respondent indicates or write down the name of a place close to the homestead (5-100m) or the name of an 'other' place.*

1. Close to the homestead *(5-100m)*: ____________
2. Site A - Chinyamatede Mt.
3. Site B - Hapare For.
4. Site C - Ngungungu Mt.
5. Site D - Chinyamupoma Mt.
6. Site E - Nematowe Mt.
7. Site F - Chiire R.
8. Site G - Odzi R.
9. Site H - Murare R.
10. Site I - Chitakanga Strm.
11. Site J - Chaseyama Mt.
12. Site K - Chisamba Strm.
13. Site L - Nemuntenzi For.
14. Site M - Zongo For.
15. Site N - Mukorahwa Strm.

Other-A: ____________
Other-B: ____________
Other-C: ____________

9. On this particular trip which member(s) of your household collected firewood and how was it carried? *Write down first daughter, mother, father, etc. and put an X under how it was carried.*

Household Member(s)	Headload	Scotchcart Borrowed Owned		Wheelbarrow Borrowed Owned	

10. How long were you away from home during this trip? *Fill in the appropriate amount of time in hours and minutes.*

____

11. What was (or will be) the use of the firewood collected on this trip?
  1. Cooking
  2. Warmth
  3. Brick Making
  4. Metal Working
  5. Making Charcoal
  6. Other *(specify)*: ______________________
  9. Don't Know

12. On this trip did you walk or collect with someone from another household?
  1. Yes
  2. No
  9. Don't know

13. What species of firewood did you collect on this trip? *Write down the names of the first five species named.*

____
____
_____.

14. Based on other places that firewood is available how would you rate the difficulty of traveling and collecting firewood on this trip?
  1. Easy
  2. Moderate
  3. Hard
  9. Don't Know

15. Did you ever have a conversation with someone from **another** household about collecting firewood at the place you visited on this trip? If yes, with who?
  1. No
  2. Yes A. Neighbor.
    B. Chief
    C. Sabhuka (Kraal head)
    D. Someone else *(specify)*:

____
  9. Don't Know

16. On this trip there may have been some other pleasant or useful things that you did or collected. For example there may have been some fruits, medicines or other useful plants, or small animals that you collected. Or you may have been able to stop at your garden or visit a friend. *Put an X (or write down any 'other' activity) down for the activities indicated to have occurred when away from home collecting firewood on this trip.*

Fruits	Herbs	Garden	Relish	Friend	Animals	Other

17. If more homesteads were established close to this place, would you still have collected firewood there on this trip?
  1. Yes
  2. No
  9. Don't Know

Section 3.

Based on the following that were identified as places your household might collect firewood from *(their choice set)*, more questions will be asked.

1. Close to the homestead *(5-100m)*: ____________________
2. Site A - Chinyamatede Mt.
3. Site B - Hapare For.
4. Site C - Ngungungu Mt.
5. Site D - Chinyamupoma Mt.
6. Site E - Nematowe Mt.
7. Site F - Chiire R.
8. Site G - Odzi R.
9. Site H - Murare R.
10. Site I - Chitakanga Strm.
11. Site J - Chaseyama Mt.
12. Site K - Chisamba Strm.
13. Site L - Nemuntenzi For.
14. Site M - Zongo For.
15. Site N - Mukorahwa Strm.

Other-A: ____________________

Other-B: ____________________

Other-C: ____________________

78. Have you ever spoken about collecting firewood at ____________ *(place)* in conversation with **another** household? *Ask this question separately for each place in their choice set (Y-yes, N-no, ?-Don't Know).*

Places:	Y/N/?:
1. Close to homestead: ____________	________
2. Site A - Chinyamatede Mt.	________
3. Site B - Hapare For.	________
4. Site C - Ngungungu Mt.	________
5. Site D - Chinyamupoma Mt.	________
6. Site E - Nematowe Mt.	________
7. Site F - Chiire R.	________
8. Site G - Odzi R.	________
9. Site H - Murare R.	________
10. Site I - Chitakanga Strm.	________
11. Site J - Chaseyama Mt.	________
12. Site K - Chisamba Strm.	________
13. Site L - Nemuntenzi For.	________
14. Site M - Zongo For.	________
15. Site N - Mukorahwa Strm.	________
Other-A: ____________	________
Other-B: ____________	________
Other-C: ____________	________

79. Are you **usually** accompanied by someone from **another** household when collecting firewood at ______________ *(place)? Ask this question separately for each place in their choice set.. (Y-yes, N-no, ?-Don't Know).*

Places:	Y/N/?:
1. Close to homestead: ________________	________
2. Site A - Chinyamatede Mt.	________
3. Site B - Hapare For.	________
4. Site C - Ngungungu Mt.	________
5. Site D - Chinyamupoma Mt.	________
6. Site E - Nematowe Mt.	________
7. Site F - Chiire R.	________
8. Site G - Odzi R.	________
9. Site H - Murare R.	________
10. Site I - Chitakanga Strm.	________
11. Site J - Chaseyama Mt.	________
12. Site K - Chisamba Strm.	________
13. Site L - Nemuntenzi For.	________
14. Site M - Zongo For.	________
15. Site N - Mukorahwa Strm.	________
Other-A: ________________	________
Other-B: ________________	________
Other-C: ________________	________

80. Would you be upset if you saw someone from Jinga, **but whose household is located on the other side of the village from you**, collecting firewood at ____________ *(place)* as well? *Ask this question separately for each place in their choice set. (Y-yes, N-no, ?-Don't Know).*

Places:	Y/N/?:
1. Close to homestead: ________________	________
2. Site A - Chinyamatede Mt.	________
3. Site B - Hapare For.	________
4. Site C - Ngungungu Mt.	________
5. Site D - Chinyamupoma Mt.	________
6. Site E - Nematowe Mt.	________
7. Site F - Chiire R.	________
8. Site G - Odzi R.	________
9. Site H - Murare R.	________
10. Site I - Chitakanga Strm.	________
11. Site J - Chaseyama Mt.	________
12. Site K - Chisamba Strm.	________
13. Site L - Nemuntenzi For.	________
14. Site M - Zongo For.	________
15. Site N - Mukorahwa Strm.	________
Other-A: ________________	________
Other-B: ________________	________
Other-C: ________________	________

81. Would you be upset if you saw someone from **another village** collecting firewood at ______________ *(place)* as well? *Ask this question separately for each place in their choice set (Y-yes, N-no, ?-Don't Know).*

Places:	Y/N/?:
1. Close to homestead: ______________	________
2. Site A - Chinyamatede Mt.	________
3. Site B - Hapare For.	________
4. Site C - Ngungungu Mt.	________
5. Site D - Chinyamupoma Mt.	________
6. Site E - Nematowe Mt.	________
7. Site F - Chiire R.	________
8. Site G - Odzi R.	________
9. Site H - Murare R.	________
10. Site I - Chitakanga Strm.	________
11. Site J - Chaseyama Mt.	________
12. Site K - Chisamba Strm.	________
13. Site L - Nemuntenzi For.	________
14. Site M - Zongo For.	________
15. Site N - Mukorahwa Strm.	________
Other-A: ______________	________
Other-B: ______________	________
Other-C: ______________	________

82. **If** several more homesteads were established close to ________ *(place)*, would you still consider collecting firewood at this place? *(Y-yes, N-no, ?-Don't Know).*

Places:	Y/N/?:
1. Close to homestead: ______________	________
2. Site A - Chinyamatede Mt.	________
3. Site B - Hapare For.	________
4. Site C - Ngungungu Mt.	________
5. Site D - Chinyamupoma Mt.	________
6. Site E - Nematowe Mt.	________
7. Site F - Chiire R.	________
8. Site G - Odzi R.	________
9. Site H - Murare R.	________
10. Site I - Chitakanga Strm.	________
11. Site J - Chaseyama Mt.	________
12. Site K - Chisamba Strm.	________
13. Site L - Nemuntenzi For.	________
14. Site M - Zongo For.	________
15. Site N - Mukorahwa Strm.	________
Other-A: ______________	________
Other-B: ______________	________
Other-C: ______________	________

83. Are you restricted from collecting at ______________ *(place)* at certain times of the week, month, or year? *(Y-Yes, N-No, ?-Don't Know)* If yes, when are you restricted? *Write when the restriction occurs, or ? if they are unsure. Ask this question separately for each place in their choice set.*

Places:	Y/N/?:	When:
1. Close to homestead: ____________	____	________
2. Site A - Chinyamatede Mt.	____	________
3. Site B - Hapare For.	____	________
4. Site C - Ngungungu Mt.	____	________
5. Site D - Chinyamupoma Mt.	____	________
6. Site E - Nematowe Mt.	____	________
7. Site F - Chiire R.	____	________
8. Site G - Odzi R.	____	________
9. Site H - Murare R.	____	________
10. Site I - Chitakanga Strm.	____	________
11. Site J - Chaseyama Mt.	____	________
12. Site K - Chisamba Strm.	____	________
13. Site L - Nemuntenzi For.	____	________
14. Site M - Zongo For.	____	________
15. Site N - Mukorahwa Strm.	____	________
Other-A: ____________	____	________
Other-B: ____________	____	________
Other-C: ____________	____	________

Questions for the Enumerators:

Finish time of the survey ____________________

Total time spent of the survey: Hours ________ Minutes __________

Sex of respondents:
1. Male
2. Female
3. Both Male and Female

Survey Status:
1. Complete
2. Incomplete

If incomplete, explain why:

Household Firewood Collection Survey
Jinga Village - May 1999 - Week 2

Introduction:

- Greetings. This is the second visit.
- A survey to learn about the places you collect firewood.
- Information to help a student - Larry Hegan - from the University of Alberta, Canada, working with the University of Zimbabwe - Answering these questions will also help the people of Jinga to understand more about firewood.
- Individual responses are confidential.
- Village leaders have given permission for this study.
- Participation is voluntary.

Household ID # ____________________
Date Begun ______________ Date Completed __________________
Approximate Start Time of Survey ___________________

Certification:
I certify on my honor that this interview, according to the agreement I have made as an enumerator, will be conducted honestly and completely.

____
Printed Name of Enumerator

________________________ _____________
Signature of Enumerator Date Completed

Section 1

1. HOW MANY SEPEARATE TRIPS to collect firewood, used by **your** household, collected in any way, did members from your household make DURING THE LAST SEVEN DAYS? _________________

2. On which DAYS OF THE WEEK, to which PLACE were each of these trips taken, and how LONG were you away from home ? *Only record the last seven trips, starting with the least recent of the seven..*

Trip #1 ___________ Place: ____________ Time: ____________

Trip #2 ___________ Place: ____________ Time: ____________

Trip #3 ___________ Place: ____________ Time: ____________

Trip #4 ___________ Place: ____________ Time: ____________

Trip #5 ___________ Place: ____________ Time: ____________

Trip #6 ___________ Place: ____________ Time: ____________

Trip #7 ___________ Place: ____________ Time: ____________

Section 2

3. LAST time the following were identified as places your household might collect firewood: (go through places identified below)

CAN ANY HOUSEHOLD WITHIN WALKING DISTANCE COLLECT FIREWOOD AT ____________ WITHOUT ASKING FOR PERMISSION? (Y-Yes, N-NO, ?-Don't Know) Ask question separately for each place identified below.

PLACE	ALLOWED (Y/N/?)
1. Close to the homestead *(5-100m)*: ____________	____
2. Site A - Chinyamatede Mt.	____
3. Site B - Hapare For.	____
4. Site C - Ngungungu Mt.	____
5. Site D - Chinyamupomo Mt.	____
6. Site E - Nematowe Mt.	____
7. Site F - Chiire R.	____
8. Site G - Odzi R.	____
9. Site H - Murare R.	____
10. Site I - Chitakanga Strm.	____
11. Site J - Chaseyama Mt.	____
12. Site K - Chisamba Strm.	____
13. Site L - Nemuntenzi For.	____
14. Site M - Zongo For.	____
15. Site N - Mukorahwa Strm.	____
Other-A: ____________	____
Other-B: ____________	____
Other-C: ____________	____

4. WHERE WOULD YOU GO TO COLLECT FIREWOOD IF YOU COULD NO LONGER COLLECT AT ANY OF THESE PLACES?

(PLACE #1): ____________

I would like to ask you some questions about ____________
(PLACE #1)

5. HOW LONG are would you be away from home while collecting firewood at ____________ *(place #1)? Fill in the appropriate amount of time in hours and minutes.*

____

6. Would you at times walk or collect with someone from ANOTHER HOUSEHOLD when collecting firewood at ____________ *(place #1)?*

1. Yes
2. No
9. Don't know

7. Based on other places that firewood is available how would you RATE THE DIFFICULTY of traveling and collecting firewood at ____________ *(place #1)?*

1. Easy
2. Moderate
3. Hard
9. Don't Know

8. Would you talk with ANOTHER HOUSEHOLD about collecting firewood at ____________ (place #1)? If yes, with who?
1. No
2. Yes A. Neighbor.
 B. Chief
 C. Sabhuku (Kraal head)
 D. Someone else *(specify)*:

____
9. Don't Know

9. What are some OTHER THINGS or ACTIVTIES that you could do besides collecting firewood when going to or collecting at ____________ *(place #1)? Put an X (or write down any 'other' activity) down for the activities indicated to have occurred when away from home collecting firewood at this place.*

Fruits	Herbs	Garden	Relish	Friend	Animals	Other

10. IF MORE HOMESTEADS ARE ESTABLISHED close to ____________ *(place #1)*, would you still consider collecting firewood from this place?

1. Yes
2. No
9. Don't Know

11. Would you be UPSET if you saw someone from THE OTHER SIDE OF JINGA VILLAGE from your household collecting firewood at ____________ *(place #1)?*

1. Yes
2. No
9. Don't Know

12 Would you be UPSET if you saw someone from ANOTHER VILLAGE collecting firewood at ____________ *(place #1)?*

1. Yes
2. No
9. Don't Know

13. Can <u>any</u> household within walking distance collect firewood at ____________ *(place #1)* WITHOUT asking for PERMISSION.

1. Yes
2. No
9. Don't Know

Section 3

I would like to ask you questions about the following places:

Place #2: ______________________________

Place #3: ______________________________

Place #4: ______________________________

Place #5: ______________________________

Place #6: ______________________________

PLACE # 2: ______________________
(Repeated for Places 3 –6)

14. Are you allowed to collect firewood at ________________
(place #2) WITHOUT asking for anyone for PERMISSION?
    1. Yes
    2. No
    9. Don't know

15. HOW LONG are would you be away from home while collecting firewood at ______________ *(place #2)? Fill in the appropriate amount of time in hours and minutes.*

____

16. Would you at walk or collect with someone from ANOTHER HOUSEHOLD when collecting firewood at ____________ *(place #2)?*
    1. Yes
    2. No
    9. Don't know

17. Based on other places that firewood is available how would you RATE THE DIFFICULTY of traveling and collecting firewood at ____________ *(place #2)?*
    1. Easy
    2. Moderate
    3. Hard
    9. Don't Know

18. Would you talk with ANOTHER HOUSEHOLD about collecting firewood at ________________ (place #2)? If yes, with who?
1. No
    2. Yes
        A. Neighbor.
        B. Chief
        C. Sabhuku (Kraal head)
        D. Someone else *(specify)*:
        ____
    9. Don't Know

19. What are some OTHER THINGS or ACTIVTIES that you could do besides collecting firewood when going to or collecting at __________________ *(place #2)? Put an X (or write down any 'other' activity) down for the activities indicated to have occurred when away from home collecting firewood at this place.*

Fruits	Herbs	Garden	Relish	Friend	Animals	Other

20. IF MORE HOMESTEADS ARE ESTABLISHED close to ______________ *(place #1)*, would you ever consider collecting firewood from this place?
    1. Yes
    2. No
    9. Don't Know

21. Would you be UPSET if you saw someone from THE OTHER SIDE OF JINGA VILLAGE from YOUR household collecting firewood at __________________ *(place #2)*?
    1. Yes
    2. No
    9. Don't Know

22 Would you be UPSET if you saw someone from ANOTHER VILLAGE collecting firewood at ________________________ *(place #2)*?
    1. Yes
    2. No
    9. Don't Know

23. Can <u>any</u> household within walking distance collect firewood at __________________ *(place #2)* WITHOUT asking anyone for PERMISSION.
    1. Yes
    2. No
    9. Don't Know

Section 4.

64. In the last year have you ever employed someone to collect firewood for you? If yes, were they permanently or temporarily employed?
  1. No
  2. Yes A. Permanent
     B. Temporary
  9. Don't Know

65. Indicate the sources and amounts of total yearly income in the last year.
All answers in dollars, rounded to the nearest dollar.

Crops? ____________
Gardens? ____________
Honey ? ____________
Beer Brewing? ____________
Brick Making? ____________
Crafts? ____________
Pensions? ____________
Employment Wages? ____________
Family outside Jinga? ____________
Other: ____________________ ____________

Questions for the Enumerators:

Finish time of the survey ____________________

Total time spent of the survey: Hours ________ Minutes __________

Sex of respondents:
1. Male
2. Female
3. Both Male and Female

Survey Status:
1. Complete
2. Incomplete

If incomplete, explain why:

Household Firewood Collection Survey
Jinga Village - May 1999 - Week 3

Introduction:

- Greetings. This is the third visit.
- A survey to learn about the places you collect firewood.
- Information to help a student - Larry Hegan - from the University of Alberta, Canada, working with the University of Zimbabwe - Answering these questions will also help the people of Jinga to understand more about firewood.
- Individual responses are confidential.
- Village leaders have given permission for this study.
- Participation is voluntary.

0

Household: ______________________________

Date Begun ____________ Date Completed ______________
Approximate Start Time of Survey ________________

Certification:
I certify on my honor that this interview, according to the agreement I have made as an enumerator, will be conducted honestly and completely.

____
Printed Name of Enumerator

____________________ ____________
Signature of Enumerator Date Completed

Section 1

1. HOW MANY SEPEARATE TRIPS to collect firewood, used by **your** household, collected in any way, did members from your household make DURING THE LAST SEVEN DAYS? ______________

2. On which DAYS OF THE WEEK, to which PLACE were each of these trips taken, and how LONG were you away from home ? *Only record the last seven trips, starting with the least recent of the seven..*

Trip #1 __________ Place: __________ Time: __________

Trip #2 __________ Place: __________ Time: __________

Trip #3 __________ Place: __________ Time: __________

Trip #4 __________ Place: __________ Time: __________

Trip #5 __________ Place: __________ Time: __________

Trip #6 __________ Place: __________ Time: __________

Trip #7 __________ Place: __________ Time: __________

Section 2

I would like to ask you questions about the following places:

Place #1: ______________________

Place #2: ______________________

Place #3: ______________________

Place #4: ______________________

Place #5: ______________________

PLACE # 1: ______________________
(Repeated for Places 2 –5)

3. Are you allowed to collect firewood at ____________________ (place #1) WITHOUT asking for anyone for PERMISSION?
   1. Yes
   2. No
   9. Don't know

4. HOW LONG are would you be away from home while collecting firewood at __________________ *(place #1)? Fill in the appropriate amount of time in hours and minutes.*

____

5. Would you at walk or collect with someone from ANOTHER HOUSEHOLD when collecting firewood at ______________ *(place #1)?*
   1. Yes
   2. No
   9. Don't know

6. Based on other places that firewood is available how would you RATE THE DIFFICULTY of traveling and collecting firewood at ______________ *(place #1)?*
   1. Easy
   2. Moderate
   3. Hard
   9. Don't Know

7. Would you talk with ANOTHER HOUSEHOLD about collecting firewood at ____________________ (place #1)? If yes, with who?
1. No
2. Yes
   A. Neighbor.
   B. Chief
   C. Sabhuku (Kraal head)
   D. Someone else *(specify)*: ____________________

9. Don't Know

8. What are some OTHER THINGS or ACTIVTIES that you could do besides collecting firewood when going to or collecting at ________________ *(place #1)? Put an X (or write down any 'other' activity) down for the activities indicated to have occurred when away from home collecting firewood at this place.*

Fruits	Herbs	Garden	Relish	Friend	Animals	Other

9. IF MORE HOMESTEADS ARE ESTABLISHED close to ______________ *(place #1)*, would you ever consider collecting firewood from this place?

1. Yes
2. No
9. Don't Know

10. Would you be UPSET if you saw someone from THE OTHER SIDE OF JINGA VILLAGE from YOUR household collecting firewood at ________________ *(place #1)*?

1. Yes
2. No
9. Don't Know

11 Would you be UPSET if you saw someone from ANOTHER VILLAGE collecting firewood at ______________________ *(place #1)*?

1. Yes
2. No
9. Don't Know

12. Can **<u>any</u>** household within walking distance collect firewood at ________________ *(place #1)* WITHOUT asking anyone for PERMISSION.

1. Yes
2. No
9. Don't Know

Appendix E. Fuelwood Collection Sites

No.	Site Name
1	Chinyamatede Mtn.
2	Hapare Village*
3	Ngungungu Mtn.
4	Chinyamupomo Mtn.
5	Nematowe Forest
6	Chiire Stream
7	Odzi River
8	Murare River
9	Chitakanga Stream
10	Chaseyama Mtn.
11	Chisamba Stream
12	Nemuntenzi Village*
13	Zongo Forest
14	Mukorahwa Stream
15	Moutain (no name)
16	Hitira Forest
17	Changuna Mtn.*
18	Garawakafara Forest
19	Nyamatende Forest*
20	Mutsike Forest
21	Forest – 1 (no name)
22	Forest – 2 (no name)
23	Agric. Fields –1**
24	Chinyanjeza Mtn.
25	Sutu Kopje
26	Muwawa Forest*
27	Agric. Fields – 2
28	General Area – 1
29	General Area – 2
30	General Area – 3
31	General Area – 4
32	General Area – 5
33	Agric. Fields – 3
34	Agric. Fields – 4
35	Bocha Village*
36	Tsingano Forest
37	Mangweka Hill
38	Muuyu Wemago
39	Chayamiti Mtn*
40	Agric. Fields - 5
41	Agric. Fields – 6
42	Agric. Fields – 7
43	Agric. Fields – 8
44	Agric. Fields – 9
45	Agric. Fields – 10
46	Agric. Fields – 11
47	Agric. Fields – 12

* - Site in an adjacent village ** - Site in close proximity to one or more agricultural fields.