FUELWOOD USE BY RURAL HOUSEHOLDS IN THE BRAZILIAN ATLANTIC FOREST

A Thesis

by

KELLIE JOAN WILCOX-MOORE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2010

Major Subject: Geography

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Approved by:

Chair of Committee,	Christian Brannstrom
Committee Members,	Andrew Millington
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ABSTRACT

Fuelwood Use by Rural Households in the Brazilian Atlantic Forest.

(May 2010)

Kellie Joan Wilcox-Moore, B.A., Austin College

Chair of Advisory Committee: Dr. Christian Brannstrom

Fuelwood is an important source of domestic energy in rural regions of Brazil. In the *Zona da Mata* of Minas Gerais, native species from the Atlantic Forest are an important source of fuelwood, supplemented by wood from eucalyptus and coffee plantations. The use of native species is complicated by their increasing scarcity and the recent enforcement of forest policies that prohibit the felling of even dead natives trees without a permit. In this study, the factors contributing to the use of fuelwood in this region, despite the simultaneous use of liquid petroleum gas in most households, are explored by examining fuelwood use patterns in four small rural communities in the *Zona da Mata Mineira* using household surveys and semi-structured interviews.

Two hypotheses were tested using a Jacknife regression. The first hypothesis, based on the energy ladder model, tested the predictive power of socioeconomic status in relation to fuelwood use. Two dependent variables were used to represent the importance of fuelwood to a household: the amount of time a household spent collecting fuelwood (Effort) and the number of purposes a household used fuelwood for (Class of Fuelwood Use). Socioeconomic status did explain a statistically significant percentage of the variance in Effort, but not in Class of Fuelwood Use.

The second hypothesis tested for a moderating effect of the availability of fuelwood on the relationship between the socioeconomic status of a household and the dependent variables. The interaction between access to fuelwood and socioeconomic status was shown to explain a significant percentage of the variance in Effort, thereby indicating that the effect of socioeconomic status on time spent collecting fuelwood depends on access to fuelwood. However, there was no statistically significant

interaction found between Class of Fuelwood Use and fuelwood availability.

The Atlantic Forest Policy was found to have little influence on domestic energy decisions made by surveyed households. Few research subjects had a good understanding of the basic tenets of this policy and the Forest Police do not have adequate resources to enforce the policy at this level.

DEDICATION

I would like to dedicate this thesis to the residents of the villages in Rosario de Limeira who participated in this study. This study would not have been possible without the help of each person who took time out of his or her busy day to talk with me and trust me enough to share personal information regarding their livelihoods.

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I would like to thank my committee chair, Dr. Brannstrom, and my committee members, Dr. Millington, Dr. Kreuter, and Dr. Stronza, for their assistance in planning, conducting and analyzing this research.

I would also like to thank my friends and colleagues as well as the department faculty and staff for contributing to my positive experience at Texas A&M University. Special thanks go to Michael Sorice for his invaluable assistance with the statistical analysis of my data. I also want to extend my gratitude to Iracambi Atlantic Rainforest Research and Conservation Center, which provided my accommodation during the fieldwork and assisted with arranging access to the communities surveyed. Additionally, I would like to thank all of the survey and interview participants for taking the time to contribute to this study.

Finally, I would like to thank my family for their support, without which I would not have been able to complete this thesis. Thanks to my father for his encouragement and guidance in pursuing this degree, and to my mother for supporting me and my family throughout my studies, particularly during our time in the field. Thanks also to my husband for his unwavering support and particularly for his help making the fieldwork in Brazil possible. Special thanks goes to my oldest son for his assistance with my field research.

NOMENCLATURE

AF	Atlantic Forest
AWC	Advanced Wood Combustion
IBAMA	Brazilian Institute of the Environment and Natural Resources
IBDF	Brazilian Institute of Forestry Development
IBGE	Brazilian Institute of Geography and Statistics
IEA	International Energy Agency
IEF	State Institute of Forests (Minas Gerais, Brazil)
LPG	Liquid Petroleum Gas
LR	Legal Reserve
MME	Brazilian Ministry of Mines and Energy
NGO	Non-governmental Organization
PPA	Permanent Protection Area

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CHAPTER I

INTRODUCTION

1.1 Background

Despite the worldwide increase in the use of fossil fuels, wood maintains a fundamental role in the global energy matrix; it is estimated that two out of six people use wood as their main source of energy (FAO, 2003). Currently the use of fuelwood occurs mostly in the industrial and domestic sectors of developing countries (Brito, 2007). Some developing countries have attempted to introduce cleaner and more convenient forms of energy, such as electricity or liquid petroleum gas (LPG), into rural households. This type of intervention is encouraged by international development agencies such as the United Nations, which recommends halving the number of households using biomass for cooking by 2015 (IEA, 2006). Despite such efforts, many developing households continue to rely heavily on wood to fulfill domestic energy needs, in part because alternatives such as LPG are often too costly or are associated with the high fixed costs of appliances (Taylor, 2005; Israel, 2002). The reasons for persistent fuelwood use and the impacts of this activity need to be examined further, especially in South America, where tens of millions of users are predicted by 2030 (IEA, 2002), but where relatively few studies have been undertaken in comparison to other regions where fuelwood use is prominent, such as Africa and Asia.

This thesis follows the style of *World Development*.

Fuelwood is an important source of industrial and domestic energy in Brazil, contributing to 11.42% of the national energy budget (Brito, 2007). Federal subsidies for LPG were cut in 2001, making fuelwood the most economical energy source for many poor households (Lucon *et al*, 2004). In a region of Brazil known as the *Zona da Mata Mineira*[1], rural households are reported to rely on wood as their main sources of energy (Silveira, 2008). Traditionally, fuelwood was sourced from the local Atlantic Forest (AF), an umbrella term for a mosaic of forest ecosystems that once dominated the coast of Brazil and still support high biodiversity and endemism. These forests are now extremely fragmented and by some reports have been reduced to 7% of their original distribution (Tabarelli *et al*, 2005). Although fuelwood harvesting is not the main cause of Atlantic Forest deforestation, it is often assumed that this activity has detrimental impacts on native forests (Hodge *et al*, 1997; Lucon et al, 2004; Tabarelli *et al*, 2005). Numerous restrictions of the forest have been enacted, such as the "national heritage" status conveyed to the Atlantic Forest by Brazil's 1988 constitution. Overall, wood resources of the Atlantic Forest have become legally inaccessible to rural populations who must find other sources of domestic energy or risk breaking the law.

This study has sought to understand the economic, cultural, political and environmental factors that influence domestic fuel choices in rural communities located in the *Zona da Mata Mineira*. This research has been situated in the contextual framework of the energy ladder model and has the following objectives:

1. To test the applicability of the energy ladder model in the municipality of Rosário da Limeira in Minas Gerais, Brazil;
2. To analyze other factors contributing to domestic fuel choices of households in rural communities in this region;

[1] The "Zona da Mata" means "Forest Zone" and for the purposes of this proposal refers to the southeastern region of the state of Minas Gerais where the natural vegetation is predominately classified broadly as Atlantic Forest. This is different from the coastal Zona da Mata, which comprises the northeastern coastal states.

3. To assess rural households' understanding of state and federal forest policies and analyze how these policies influence the choices that households make regarding domestic fuel.

1.2 The Energy Ladder in Developing Countries

The concept of the energy ladder has been used in the study of energy-use patterns in developing countries since the early 1980's and is currently the most pervasive framework for describing household energy transitions (Hosier, 2004). This conceptual model describes the transitions that households make from reliance on traditional biomass-based energy sources to using progressively more modern, higher density fuels such as kerosene, charcoal and gas and thereby moving up the 'energy ladder'. The energy ladder concept is based on the notion that modern fuels have fewer disadvantages associated with their use and are therefore more desirable, although more expensive, than traditional fuels. Implicit in this model is the idea that fuel types are associated both locally and internationally with a certain status (Masera *et al*, 2000). For example, fuelwood has been construed as "the fuel of the poor" (Hiemstra-van der Horst and Hovorka, 2008).

At the household scale, decision makers must consider the social, economic, health-related and environmental costs and benefits of all available fuel types in order to make choices based on these factors. In many cases, poor and wealthy households in the same area will exhibit different fuel-use patterns in response to their different abilities to access the rungs of the ladder (Hosier, 2004) (Figure 1). Movement up the ladder to more modern fuel types is associated with a change in status, often related to income and/or education (Israel, 2002). Other factors which can either drive or constrain movement up and down the energy ladder include household location (rural or urban), how clean a fuel is to handle and to burn, fuel availability, the relative costs of fuels and whether or not governments offer subsidies, and the cost of appliances (Israel, 2002; Hosier, 2004).

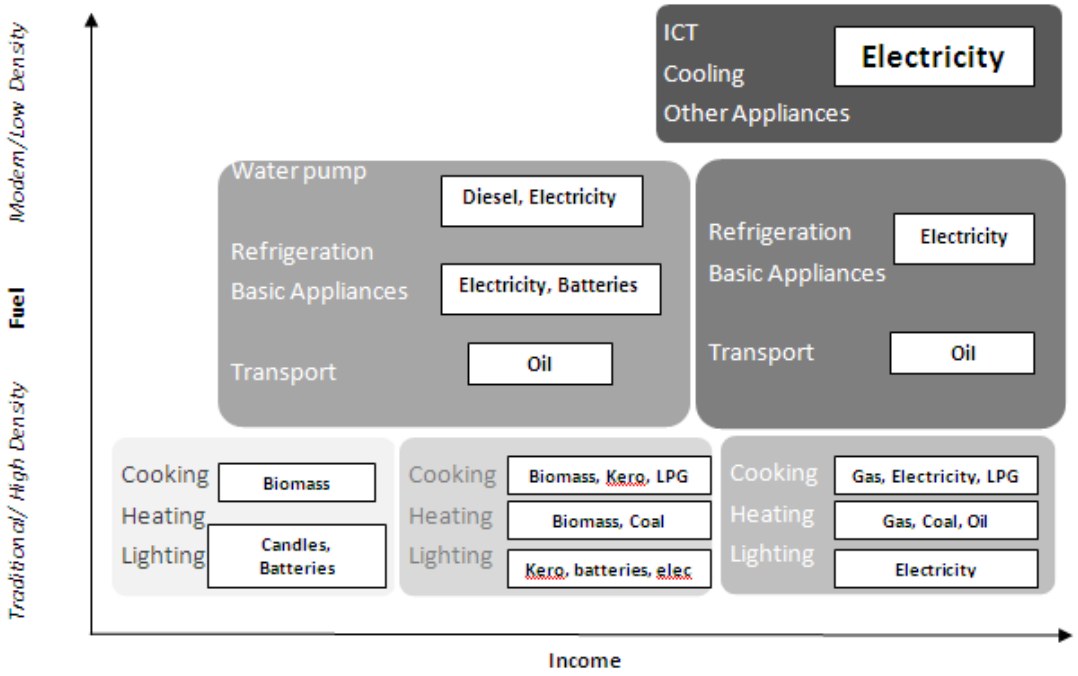

Figure 1: End uses and fuels choices faced by households at different income levels. Modified from World Energy Outlook (2002), International Energy Agency (IEA).

Although the energy ladder has been a useful framework for researchers and policy analysts to conceptualize the fuel transitions undergone by households in the development process, it has been criticized from several angles. In their article entitled *Reassessing the energy ladder*, Hiemstra-van der Horst and Hovorka (2008) write that "just as case study analyses that do not take an energy ladder approach are rare, equally, it is difficult to find one in which the data do not contradict one of more of the model's assumptions". One criticism of the model is that structuring of fuel types in a hierarchical order automatically leads to judgments on societies based on the types of fuel they use (Hosier, 2004). Societies are expected to modernize by advancing their fuel use formulaically, like school children graduating from one grade to the next. Societies that persist on the lower rungs of the energy ladder are considered stalled and their progression retarded by their inferior choice of fuel. This type of thinking can be seen as counterproductive given that some researchers have found that so-called low-

rung fuels are often the most appropriate choice for rural societies in developing countries (Taylor, 2005). Although wood may not be as convenient as other fuels and does not burn as cleanly, it can be argued that in certain circumstances these disadvantages are outweighed by advantages; wood is frequently the most accessible and affordable fuel option, it does not require the purchase of appliances with large up front costs and the use of wood is often fully integrated into the local way of life. It has been argued that energy planning in the rural areas of developing nations is most effective if it does not attempt to replace traditional energy sources but rather works with communities to strengthen the production systems of these fuels (Taylor, 2005). In such cases, the tenacious adherence of policy-makers to the idea of moving up the energy ladder can result in wasted money that would have been better spent on other developmental issues that are often of more importance to local people, such as clean water and education (Taylor, 2005).

Another criticism of the energy ladder is that the association between increased income and decreased consumption of traditional biomass can be problematic (Israel, 2002). While an increase in household income is often correlated with the transition to more modern fuels and therefore with a decrease in fuelwood consumption, in households where fuelwood is purchased a higher income could potentially lead to more fuelwood being used simply because households can afford to buy more.

The energy ladder concept is also criticized for failing to represent the complexities of real-world household fuel usage (Hosier, 2004). Some household fuel budgets are composed of two or more types of fuel, some households may move up and down the ladder as household fortunes change, and sometimes ladder rungs are skipped. The latter pattern of energy transition is described as leapfrogging and is a less conventional alternative for developing households that allows them to bypass petroleum-based fuels and skip directly to the use of more efficient and environmentally friendly technologies (Murphy, 2001). Other researchers have found that the pattern of change in energy use cannot always be represented by a linear transition along the energy ladder. Even in areas where electricity is provided by the government it may

only have limited use and more traditional forms of energy may be retained for important activities like cooking (Madubansi and Shackleton, 2006).

An additional limitation to the energy ladder is that it fails to take into account power dynamics within households. In households where women are responsible for gathering and cooking with wood (and are therefore more likely to suffer any resulting negative impacts) but men are the only income earners, the transition to cleaner and more convenient forms of energy may not be given priority. Studies have shown that when female-earned income increases, the proportion of the household budget allocated to fuel increases as well and consumption of fuelwood decreases (Israel, 2002; Hoddinott and Haddad, 1995).

A final criticism is that urban households tend to follow the pattern of energy transition predicted by the energy ladder concept more closely than do rural households (Hosier, 2004). Hosier notes that, in general, rural fuel use is predicated mainly on fuel availability rather than other economic factors, and policy-makers have relatively little influence on fuel choices in rural areas.

Because of the energy ladder's inadequacy in representing the complexities of domestic fuel choices, several studies have attempted to amend and even re-theorize energy transition patterns in the developing world (Hiemstra-van der Horst and Hovorka, 2008). An example of a modified energy-ladder model is Masera *et al's* (2000) "multiple fuel" model, which is based on the observation that in rural Mexico most households tend to stack fuel types rather than switch from one to another. This study found fuel types are not perfectly inter-substitutable, and therefore when new cooking technologies are added even the most traditional systems are rarely abandoned. This leads to a situation whereby even the wealthiest of households continue to use fuelwood for cooking particular foods.

Despite numerous criticisms, the energy ladder concept has yet to be widely replaced by another framework that describes household fuel choice in relation to economic development (Hosier, 2004). Consequently its continued pervasiveness in studies related to energy in the developing world is likely and potentially useful as it

provides a framework from which to compare case studies. For these reasons, I situate my case study within this framework, though I do expect to find, as most similar studies do, that fuelwood use in my study site will not conform perfectly with the model (Hiemstra-van der Horst and Hovorka, 2008).

1.3 The Fuelwood Crisis Reviewed

Although access to high-density fuels is improving for more and more people in the developing world, millions of households around the globe will continue to rely on traditional biomass to fuel their basic energy for at least the next two decades (IEA, 2006). This number will have risen by more than 40% from current values in Africa, where 700 million users are predicted in 2030. Biomass consumption is projected to decline in Asia but even so, 1.7 billion users are predicted by this same year. Seventy million users are predicted for Latin America (IEA, 2002). Traditional biomass continues to occupy a fundamental role in the global energy matrix, raising questions regarding the long-term socio-economic and environmental impacts of the continued harvesting and burning of wood, the principal source of traditional biomass.

Concerns about the sustainability of fuelwood harvesting and usage were sparked in the 1970's in the context of a broader preoccupation with fossil fuel supplies (Arnold *et al*, 2003). Fuelwood became an important energy issue when it was found that millions of households in the developing world rely on wood as the principal source of domestic energy. Concern was raised regarding the ecological impacts of harvesting wood on such a massive scale and the potential for acute wood scarcities that would impact the livelihoods of millions of people (De Montalembert and Clément, 1983). In an early and influential publication on this topic, Eckholm (1975) described the "real energy crisis" for more than one third of the world's people as the "daily scramble to find the wood they need to cook dinner". The following socio-economic consequences of fuelwood shortages were predicted:

- Women and children would be forced to spend increasing amounts of time in search of wood;

- Crop residues and animal dung would be used to replace wood, reducing the amount available for feeding livestock and fertilizing cropland and thereby reducing the productivity of subsistence farms;
- The burning of such inferior biomass would cause even more health problems than the burning of wood was said to cause;
- Nutrition would be impacted as people would eat less cooked food in an effort to consume less wood;
- What little income households had available would go towards purchasing wood, at the expense of other items and activities.

In addition to the predicted negative social impacts, forest degradation and destruction was also predicted, along with all associated issues, such as increased erosion and loss of biodiversity (Arnold *et al*, 2003).

These forecasts stimulated a restructuring of forestry programs throughout much of the world to meet fuelwood demands (Arnold *et al*, 2003). Villagers were encouraged to plant communal woodlots on their land. Other mitigation strategies were also undertaken, such as encouraging the adoption of more efficient wood-burning stoves and the substitution of wood with other forms of energy. Much attention was directed towards the concept of a "woodfuel gap" and the need to identify areas of acute wood shortages. In 1980 the Food and Agriculture Organization of the United Nations (FAO) estimated the fuelwood balance for every country and region (Arnold *et al*, 2003) by comparing current and projected fuelwood consumption with annual growth rates from existing forest stock. The results suggested that of the 2 billion people dependent on biomass fuel in 1980, over half would be unable to meet their minimum energy requirement without overcutting and 100 million were estimated to already be dealing with acute shortages of fuel (Arnold *et al*, 2003). This study prompted the UN to recommend a five-fold increase in tree planting above 1981 levels.

After a decade of focus on the impending fuelwood crisis, researchers began to question the actual impacts and importance of fuelwood scarcities (Dewees, 1989). One

problem with the fuelwood "gap" and "balance" approaches was that they estimated fuelwood supply and demand on a national scale, while issues related to fuelwood supply and uses vary depending on location (Leach and Mearns, 1988). Additionally these approaches extrapolated future fuelwood use without accounting for adaptations that households would make in the face of wood shortages (Dewees, 1989). While a scarcity of fuelwood was recognized, it was argued that most households were able to adapt to this change, depending on their circumstances. The role of fuelwood collection in deforestation was also reassessed. New studies showed that land clearance for agricultural expansion, not fuelwood harvesting, was the principal cause of forest loss (Dewees, 1989). Other predicted outcomes of fuelwood scarcity, such as increased time for wood collection and changes in cooking habits, were found to be linked to more fundamental issues related to household labor supply and economics (Dewees, 1989). Research also indicated that fuelwood shortages were not always the main concern of rural households who were often more worried about other more immediate problems like food and income deficits (Arnold et al, 2003). In sum, the fuelwood picture that materialized in the 1980's was not as dire as that predicted in the 1970's. In cases where shortages were real and did result in increased hardships, the effectiveness of forestry interventions was found to be limited (Arnold *et al*, 2003).

Findings such as these led to a marked decrease in the 1990s in fuelwood-oriented forestry programs (Arnold *et al*, 2006). A recent review of the current global fuelwood situation broadly supports the 1980s conclusions that the use of fuelwood rarely results in problems of insurmountable magnitude requiring intervention, largely due to people's ability to adapt by using other fuels or less wood. However, this same review found that people's ability to respond to fuelwood shortages varied depending on their access to resources such as land, labor and capital. As a consequence, resource-poor households have a greater potential to suffer more when wood shortages do occur. Additionally, Arnold *et al* (2006) found that in cases where fuelwood was harvested from common pool resources, such as public forests, and these resources are restricted, the impacts of fuelwood scarcities can be more severe.

An example of this type of situation can be found in rural post-apartheid villages in South Africa where villagers source wood from surrounding common property resources that are controlled by village leaders who have lost authority in the post-apartheid era (Kirkland *et al*, 2007). In recent years fuelwood has become scarce due to increased demand and lack of regulation. This scarcity has resulted in villagers having to walk longer distances to collect fuelwood, resulting in less time for other activities such as education. Some villagers have resorted to "stealing" fuelwood from the common property of other villages. This case study demonstrates the reality of problems created by genuine woodfuel gaps. It also illustrates the localized nature of these gaps, with some viilages experiencing wood shortages while neighboring villages are not.

In a recent review, Cooke *et al* (2008) acknowledge the perceived failures of the gap and balance models of the 1970's and 80's and the policies based on these approaches. However, these authors emphasize that fuelwood continues to be of critical importance to millions of rural households in developing nations, a statement which is supported by findings from the International Energy Association (IEA) in their annual World Energy Outlook report (IEA, 2002; IEA, 2006). Cooke *et al* (2008) argue that although our understanding of fuelwood issues has improved over the last three decades, there still remains much which is unknown, due in part to the location-specific nature of fuelwood issues.

These authors placed great emphasis on the need for more localized fuelwood data sets, particularly household-level studies which can be used to thoroughly investigate all aspects of fuelwood consumption including:

- Uses and substitutes;
- Policies affecting availability;
- Impacts of policies on collectors;
- Impact of fuelwood collection on the environment;
- Individualswho gather fuelwood and the households that consume it.

1.4 Fuelwood Consumption in Brazil

The use of wood to fuel both domestic and industrial needs has a long history in Brazil. In his 1995 book *With Broadax and Fireband: The Destruction of the Brazilian Atlantic Forest*, Dean argues that São Paulo's industrialization during the first half of the 20th century was primarily powered by wood from the Atlantic Forest. This argument has been critically reviewed by Brannstrom (2005), who found that in general terms Brazil relied overwhelmingly on biomass during this phase of development, although coal and hydroelectricity also played important roles.

Oil replaced wood as the primary source of industrial fuel in Brazil in 1967, and was replaced by hydroelectricity ten years later (Brito, 1997). In contrast to many other developing nations, it is the industrial, not the household, sector that represents the greatest current consumption of fuelwood in Brazil. Much of the industrial demand for wood is created by the use of charcoal in the metallurgical sector (Brito, 2007). Brazil is the world's largest producer of steel obtained using charcoal to reduce iron ore. The food, drink and ceramics sectors are the major non-metallurgical industrial consumers of woodfuel.

The residential sector is the second largest consumer of fuelwood in Brazil, with wood being used mainly to fuel cooking, heating water and, in southern regions, for heating the home (Brito, 2007). Consumption in this sector is linked to the use of LPG, which has been a substitute for fuelwood in many Brazilian homes since in became publicly available the 1930's (Lucon *et al*, 2004). In 2001 federal subsidies for LPG were cut, resulting in a cost increase of 20% for a 13kg canister of LPG (Lucon *et al*, 2004). A program called Auxílio-Gas ("gas assistance") provides 9 million Brazilian households earning less than half of one "minimum salary", or R$208.00 per month (as of January 1st, 2008 minimum salary is R$415.00), with approximately R$15 every two months to assist with purchases of fuel (one 13kg canister of gas cost approximately R$30 in 2008). It has not been documented how households that are not eligible for this grant are negotiating the higher cost of LPG, although Lucon *et al* (2004) assume that it has led to the increased use of fuelwood. The use of fuelwood in the residential sector of

Brazil has risen by 3.4% since 2000, after declining steadily for decades. Brito (2007) estimates that at least 30 million people currently rely on fuelwood as a source of domestic energy in Brazil.

According to Brazil's Decadal Plan for Energy Expansion (MME, 2007), fuelwood currently makes up 38% of energy consumed in the residential sector. This number was a reduction from 86% in 1970, but still accounts for a large proportion of domestic energy. It was estimated that up until the year 2010 wood would be used for cooking in rural households that earn less than three minimum salaries. After 2010 it is expected that only those rural households earning less than two minimum salaries will rely on fuelwood for cooking. Demand for fuelwood in Brazil is predicted to increase in the next couple of years, then decrease and then rise again, back up to the 2010 levels by 2016. Compared to the increase in demand for energy, the increase in demand for fuelwood is quite low (between 0.5% and 0.8% each year), whereas the demand for energy is expected to increase by 4.1% to 4.8% annually (MME, 2007). Despite this relatively small increase in demand for wood, the quantity of wood used as fuel in Brazil should not be dismissed; it is estimated that 220 million cubic meters of wood are currently consumed for energy in Brazil, representing 69% of all wood used in Brazil for any purpose including the production of paper and boards, panels and other sawmill products (Brito, 2007).

The wood that makes up these millions of cubic meters comes from two general sources. Plantation forests, mostly composed of fast-growing *Eucalyptus* species, have partially contributed to the supply of industrial and residential fuelwood, especially in recent times with pressure from environmental groups to eliminate the non-sustainable production of charcoal from natural forests (Brito, 1997). However, the majority of fuelwood used by industry, agriculture and households in Brazil continues to be taken from native forests (Brito, 1997). Historically, much of this wood was taken from the Atlantic Forest but according to Brito (1997) fuelwood resources from this region are now practically exhausted. Currently, it is estimated that all but 10% of the original expanse of Atlantic Forest has been cleared (Tabarelli, 2005) and since the early 1990s it

has been illegal to cut trees from any wooded area designated as Atlantic Forest (Hodge, 1997). As a consequence, the *cerrado,* a landcover type that encompasses woodlands ranging from open to closed savannas, has supplied most of the fuelwood required by the Brazilian pig iron and steel industries. However, the potential for fuelwood supply from this region is nearing its limit (Brito, 2007). In the Northeast, where much of the population relies on fuelwood, the dry scrubland vegetation cover known as *caatinga* does not offer the potential for long-term industrial fuelwood supply. The only forested area in Brazil that has this potential is the Amazon (Brito, 1997). As of 1997 there was an estimated surplus of potential wood energy in Brazil but it was highly reliant on native forests far from centers of industrialization (Brito, 1997).

Despite the continued importance of fuelwood in the residential sector of Brazil, especially among the rural poor, relatively few studies have documented the use of native Brazilian plants as energy sources. One of the few examples is Ramos *et al* (2007) who list native plants used for fuelwood in *caatinga* in the northeast of Brazil and describe harvesting methods. Even in this region, where poverty is pervasive, 50% of homes surveyed relied solely on LPG as a source of domestic fuel (mostly needed for cooking), while 45% relied on a combination of fuelwood and LPG. Only 5% of households surveyed relied entirely on fuelwood for cooking. This study identified over 57 native species as known to be used for fuelwood, although only 27 species were actually used by members of the community. Interestingly, men were noted as being more knowledgeable about plants that could be used for fuelwood, which is explained by the fact that in this region of Brazil it is the men who are typically responsible for gathering wood (contrary to what is normally assumed). Fuelwood gathering was found to take place during the summer, which is the dry season. The majority of surveyed respondents (63%) indicated that they only collected wood from agricultural fields, homegardens and private property, rather than from the adjacent forest fragments. The authors examined the potential for so many species and such quantities of wood to be supplied by these areas and determined it to be unlikely, implying that not all respondents were willing to admit to harvesting wood from forests. Dry (dead wood)

trunks were most preferred, followed closely by dry branches. But green (live wood) materials were also used, and some households owned stoves that functioned equally well with green wood.

Botrel e*t al* (2006) conducted a similar ethnobotanical survey in western Minas Gerais with the purpose of investigating all uses of native plants in the region. The authors found that the use of fuelwood is common in this region and participants in their survey cited a total of 37 plant species used for fuel. Of the 17 participants, only one did not own a wood-burning stove. The commercialization of fuelwood was mentioned by more than one respondent, with a bundle of wood sufficient for a month's use costing about R$15.00 in 2000. According to the authors, wood purchasing generally occurs during the wet months of the year when residents are busy harvesting coffee. In the dry season most households gather their own wood. In this region women are described as being the main wood collectors, mostly going out in groups and thereby turning the chore into a relatively pleasant social activity.

Participants in Botrel *et al*'s (2006) study indicated that most rural landowners in their area permit fuelwood collection on their land, as long as only dead wood in quantities small enough to carry home by hand was gathered. One participant, who was also a landowner, explained that he allowed fuelwood collection on his land in order to assist the women (who in this region are responsible for gathering wood) whose work has been made more difficult by the enforcement of forest policy and by other landowners who do not allow fuelwood collection on their property. The authors found that participants relied primarily on native species of wood, mostly due to its availability. Eucalyptus trees and coffee trees are the main non-native alternatives, but these were not found to be commonly used in this region. Most respondents did not wish to discuss fuelwood due to the illegal nature of harvesting wood from the Atlantic Forest. Survey participants were being wary of revealing the truth about which sources of fuelwood they use. When questioned about the scarcity of wood, some respondents mentioned that whereas before fuelwood was quite plentiful, now they had to walk further to find sufficient wood. Some authors have cautioned against using collection distance as a

proxy for wood scarcity (Brouwer *et al*, 1997; Dewees, 1989), but it seems that in the minds of the authors and respondents of Botrel *et al's* study the two factors are closely linked.

One interesting finding of the Botrel study is that certain plant species are abundant and have good combustible qualities but are not used for fuel purposes. Sometimes they are spared from the fire because they are needed for other purposes or they are difficult to collect, but the restricted harvesting of some species was also found to be linked to superstition. Five different species were mentioned by participants describing the mystical or religious reasons that they avoid using these plants as fuelwood (Botrel et al, 2006). This indicates that factors other than availability and combustibility may influence people's choice in fuelwood.

Alves Silveira (2008) notes that despite recent perceptions of wood scarcity, the use of fuelwood is still prominent in rural villages in the *Zona da Mata Mineira*. The author found that every household visited owned a gas stove but that most respondents preferred to cook with wood and rarely used LPG. This indicates that in this region the high up-front cost of appliances is not the limiting factor leading households to use wood over LPG, although this reasoning is often used to explain fuelwood use in other areas (Taylor, 2005; Israel, 2002). Women, in particular, complained about the scarcity of wood and seemed to link it to the restricted access to forest resources arising from the Atlantic Forest policy. For example, a female participant described how she used to gather wood from the forests but now sources her wood from the nearby coffee plantations. Another interviewee explains how he plants eucalyptus trees on his property for the purpose of selling the wood for fuel. These interviews indicate that households in this region are beginning to regularly use sources other than native trees for fuelwood.

Fuelwood harvesting has often been cited as a cause of recent degradation of the Atlantic Forest (Tabarelli *et al*, 2005; Lucon *et al*, 2004; Hodge *et al*, 1997). Lucon *et al* (2004) state that LPG has historically been the first substitute for firewood, which is obtained by poorer rural and even urban communities and that when LPG prices rise, poorer residents replace this fuel with wood, causing more deforestation. The authors

admit that the residential use of fuelwood is not one of the main causes of deforestation in Brazil, but explain that in the outskirts of urban areas, where forest fragments persist, collection of wood for domestic purposes can have a severe impact.

Tabarelli *et al* (2005) identify the harvesting of firewood as first on the list of several contributing factors to the continued degradation of the already "relentlessly exploited" Atlantic Forest. However, these authors do not identify who is harvesting this wood and how, or offer any evidence that this activity is responsible for significant degradation. The authors cite two papers in support of the statement listing fuelwood harvesting as the first of many causes of forest degradation. In the first, firewood is only mentioned once, as part of a list of commercial and subsistence forest resources (Tabarelli et al, 2004). The other paper cited in reference to this statement refers only to the extraction of heart of palm, and does not mention firewood at all (Galleti and Fernandez, 1998). Even though firewood harvesting is listed first as a cause of forest degradation, absolutely no empirical evidence was offered to support this argument, indicating that it is an assumption widely held by prominent contributors to the field of research in the Atlantic Forest, but that there may not be much evidence to support this notion.

Hodge *et al* (1997) also list fuelwood harvesting as a cause of deforestation, not only in Brazil, but worldwide. No empirical evidence or citation of any kind is cited in support of this statement. It seems that even in the recent literature, published at least a decade after the connection between fuelwood harvesting and deforestation was seriously questioned, it is still assumed that the collection of firewood at the domestic scale is a cause of deforestation. Cooke *et al* (2008) specifically mention the need for empirical evidence that either supports or refutes this assumption.

In sum, fuelwood remains an important source of domestic energy in Brazil, but due to a paucity of research in this area it's true prevalence is not known. Efforts have focused on replacing fuelwood, rather than understanding the details of its use. Few studies have collected information regarding the economic and social impacts of domestic fuelwood use in Brazil. Few studies have documented native species

commonly used for fuelwood and I have not found a study that investigates the ecological impacts of modern fuelwood collection in the Atlantic Rainforest, despite some authors claims that this activity is a cause of forest degradation. These details are important for understanding the true implications of fuelwood use and for making educated political decisions regarding the use of forest resources and the promotion of one type of fuel over another.

1.5 Atlantic Forest Policy

1.5.1 The Atlantic Forest Policy

The Brazilian Atlantic Forest extends from the southeastern portion of the country and up much of its eastern coastline. It is considered to be a "biodiversity hotspot", meaning that it is endangered (less than 100,000 km^2 or 7% of the original distribution remains) and supports a high rate of endemism (Tabarelli et al, 2005). Natural vegetative cover in this region has disappeared, replaced by a variety of urban, agropastoral and industrial sites. The potential reduction or loss of ecosystem services provided by these forests (habitat, erosion control, water storage, resource supply etc) is what motivates many environmentalists to advocate legal protection of the remaining forests in this part of Brazil.

The history of Atlantic Forest Policy begins with the original Brazilian Forest Code, created in 1934. In Minas Gerais this code served as the inspiration for the creation of the State Institute of Forests (IEF) in 1962 (Assis, 2001). The purpose of this institution was to give the state government a means of administering forest resources and controlling deforestation. Shortly after the creation of the IEF, in 1965 a new Brazilian Forest Code was instituted and a new federal forestry institution formed: the Brazilian Institute of Forestry Development (IBDF). The IBDF was short lived and in 1986 evolved into the Brazilian Institute of the Environment and Natural Resources (IBAMA), which exists to this day (Assis, 2001).

The 1965 Forest Code created two key categories of Brazilian Forest Policy: The Permanent Protection Area (PPA) and the Legal Reserve (LR) (Ahrens, 2005). The

Forest Code prohibits the removal of natural vegetation situated in the following environmentally sensitive areas, requiring that they be areas of permanent protection:

- Along rivers or any running water (the width of the required PPA increases with the breadth of the river, beginning with a minimum of 30 horizontal meters of natural vegetation along any running water);
- Around lagoons, lakes or any other natural or artificial reservoir;
- Around springs, even if they are intermittent;
- On the tops of hills, mountains and mountain ranges;
- On hillsides with a slope greater than 45 degrees;
- Any area 1,800m above sea level.

Additionally, the Forest Code requires a percentage of every rural property (80% in the Amazon, 20% in the rest of the country) to be maintained in native vegetation as the Legal Reserve, which must be registered with the land registration authorities. Resources from LRs can be extracted if the landowner has a sustainable management plan for this area approved by the appropriate environmental agency (Ahrens, 2005).

The 1988 Brazilian constitution added another layer to Atlantic Forest policy by declaring the Atlantic Forest a national patrimony, although the exact vegetation categories included in the definition of Atlantic Forest were not mentioned (Brannstrom, 2002). In 1991, the Brazilian government passed Law 99.547 prohibiting any cutting or alteration of the Atlantic rainforest, but again failed to identify which forest types were considered to fall under this law. In 1992, the government attempted to clarify the situation by passing another decree (Portaria no. 58) listing all the species of flora considered to be under threat of deforestation (Hodge *et al,* 1997). Finally, in 1993 the Brazilian president Itamar Franco issued a decree (Decree 750) specifically defining which Brazilian forests fell in the 'domain' of the Atlantic Forest. This decree grouped together three main types of forest that had been classified separately by IBGE:

- Floresta Ombrófila Densa (Dense Evergreen): occurs on the extreme coast of Brazil and has no dry season and very little mean monthly temperature variation;

- Floresta Ombrófila Mista (Semi-Evergreen);
- Floresta Estacional Semidecidual (Seasonal Semi-Deciduous): located in the southeast interior and having a defined wet and dry season as well as more varied temperatures (Hodge et al, 1997; Brannstrom, 2002).

In 1998 the Law of Environmental Crimes was enacted which strengthened penalties for a variety of environmental crimes including the illegal killing of animals, deforestation, pollution and destruction of historic preservation sites (McAllister, 2005). The Atlantic Forest Policy has continued to evolve and strengthen over the years. The most recent iteration was approved by the Brazilian Senate in December 2006 and a decree regulating this law was signed by President Luíz Inácio Lula da Silva in November 2008. This new version was 14 years in the making and its main objective is to create a more user-friendly law that can be understood by all parties. Among other changes, this iteration of the law clarifies which forest types are protected under this law, explains that land that was covered in Atlantic Forest continues to be considered as Atlantic Forest even after being burnt down, more clearly defines the terms "primary" and "secondary forest", ensures small agriculturalists and traditional populations access to convenient authorization for use of AF resources, and specifies that the government has an obligation to encourage the ecological enrichment of AF fragments, thereby giving landowners better support in RL and APP management. In practice however, this version has as yet had little significant impact on the way inhabitants of the *Zona da Mata Mineira* use the forest.

1.5.2 Enforcement of Atlantic Forest Policy in Minas Gerais

In 1991, the state of Minas Gerais enacted its own environmental law, (Law 10561), known as the Forest Law of Minas Gerais (Assis, 2001). This law is essentially a replica of the national Forest Code but with even more restrictions (Assis, 2001). The IEF is responsible for enforcing this law and according to Assis (2001) is even stricter than its national counterpart. For a decade after the creation of IBAMA in 1986, both

the federal and state forestry institutions regulated forest resources in Minas Gerais, doubling the amount of bureaucracy and necessary fees for many forest-related activities (Assis, 2001). In 1999 the IEF took control of all forest extraction and plantation and gradually increased its mandate until it became the principal entity responsible for forests in the state of Minas Gerais. Currently the IEF's responsibilities include the following activities (Assis, 2001):

- Analysis and regulation of agricultural projects and commercial forests;
- Control and regulation of the cutting of native vegetation and forest harvesting;
- Control and regulation of Areas of Permanent Protection;
- Fishing;
- Monitoring, regulation and control of the use of renewable natural resources;
- Administration of state conservation areas;
- Environmental education;
- Forest restoration.

IBAMA's role in the state of Minas Gerais is restricted to administering federal conservation areas. The Forest Police, a specialist battalion of the Military Police of Minas Gerais, assist both institutions by monitoring clandestine deforestation and poaching (Assis, 2001).

The Ministério Público is an autonomous and financially independent prosecutorial branch of the Brazilian government responsible for protecting civil rights, including environmental rights (McAllister, 2005). State public prosecutors are responsible for investigations and public civil action in cases of environmental crimes such as deforestation. In most cases, unless irreparable damage has been done to the environment, prosecutors seek extra-judicial resolutions, requiring that the responsible party take action to repair damage (McAllister, 2005).

1.5.3 Rural livelihoods and the Atlantic Forest Policy

The effectiveness of the Atlantic Forest Policy, as well as its impacts on rural livelihoods, are subjects of controversy. Hodge *et al* (1997) argue that the restrictions of the Atlantic Forest Policy have led to an increased rate of deforestation as subsistence farmers have hurried to harvest all the forest on their land before the law is strictly enforced. Even when fines are issued, the cost is generally less than the profit made from selling the forest products (Hodge *et al*, 1997). The only evidence for the broad statements made in this paper is a few conversations with rural landowners. Even so, these anecdotes support the notion that rural Brazilians are often primarily interested in the resources the forest can provide them, rather than the existence of the forest itself.

The type of conservation model that restricts access to resources makes two controversial assumptions: 1) there exists an inherent dichotomy between humans and nature and 2) rural communities are incapable of managing natural resources sustainably (Arruda, 1999). The issue becomes even more polemic because of the fact that traditional populations considered to be indigenous are granted more access to forest resources than non-indigenous populations. Indigenous groups have the right to hunt and harvest other resources from the Atlantic Forest, much to the chagrin of conservation biologists who see these activities as unsustainable (Galleti, 2001), whereas other traditional populations are subject to more restrictions because they are not considered to be indigenous to the region. The rural populations of mixed Portuguese and indigenous descent residing in Brazil's southeastern interior (including the *Zona da Mata Mineira*) are an example of a traditional population whose access to natural resources is more limited than that of indigenous groups. Overtime these populations have adopted many of the techniques, plants, words and even religious elements used by the indigenous cultures of the region, yet they also have ties to more modern cultures and are influenced by the market economy and as such have been subject to greater restrictions regarding access to forest resources (Arruda, 1999).

The impacts that the resource restrictions mandated in the AF policy have on traditional rural populations is not well documented in the literature; the few papers that

analyze the AF policy do not conduct the household-level studies necessary for this level of understanding (Hodge et al, 1997, Brannstrom 2001). This type of information is important for understanding how rural residents who use wood as a primary source of fuel adapt to the relatively recent restrictions on their traditional source of domestic energy.

CHAPTER II

STUDY SITE DESCRIPTION AND SURVEY METHODS

2.1 Study Area and Site Selection

2.1.1 The municipality of Rosário de Limeria, in the Territory of the Serra do Brigadeiro, in the Zona da Mata Mineira

Data for this study was collected from households in four villages in the municipality of Rosário de Limeira in the Brigadeiro Territory in Minas Gerais, Brazil. These villages were purposefully selected with guidance from the Community Projects Manager at the Iracambi Atlantic Forest Research Center, an NGO based in a rural community near the city of Rosário de Limeira that has assisted with previous sustainable development studies in the region (Watson and Achinelli, 2008; Silveira, 2008; Achinelli, 2003). The four villages chosen for this study are all located within 15 miles of Iracambi (20˚S, 42˚30'W) and have all participated in previous studies undertaken by Iracambi-sponsored researchers. These villages are located in the municipality of Rosário da Limeira, which falls into the *Comarca* (judicial territory) of Muriaé in the region known as the *Zona da Mata*, in the state of Minas Gerais. The *Zona da Mata* refers to the southeastern region of the state where the natural vegetation is predominately classified broadly as Atlantic Forest (Figure 2).

Minas Gerais (Minas) is one of the larger Brazilian states in terms of area but with 19.5 million inhabitants, its population is half the size of the smaller state of São Paulo. Minas is currently the most important coffee producing state in Brazil, contributing nearly 50% of Brazil's total coffee production; in Minas, 74% of the total income produced by agricultural activities comes from coffee, followed by milk at 10%. The manufacturing of iron and steel is the state's most important industry. Minas consumes 60% of charcoal produced in Brazil (AMS, 2006) and uses it to produce over 70% of the nation's charcoal-smelted pig iron and steel. This industry requires an enormous amount of wood for charcoal, most of which, until the last decade, was

supplied from native forests. According to the state census, 2.1 million cubic meters of fuelwood were produced in Minas in 2006 (IBGE, 2006). Although Rosário da Limeira is not a steel-producing region, there are other industries in the municipality, such as milk and poultry production that have provided a market for charcoal and therefore an incentive for the felling of native forests for charcoal production.

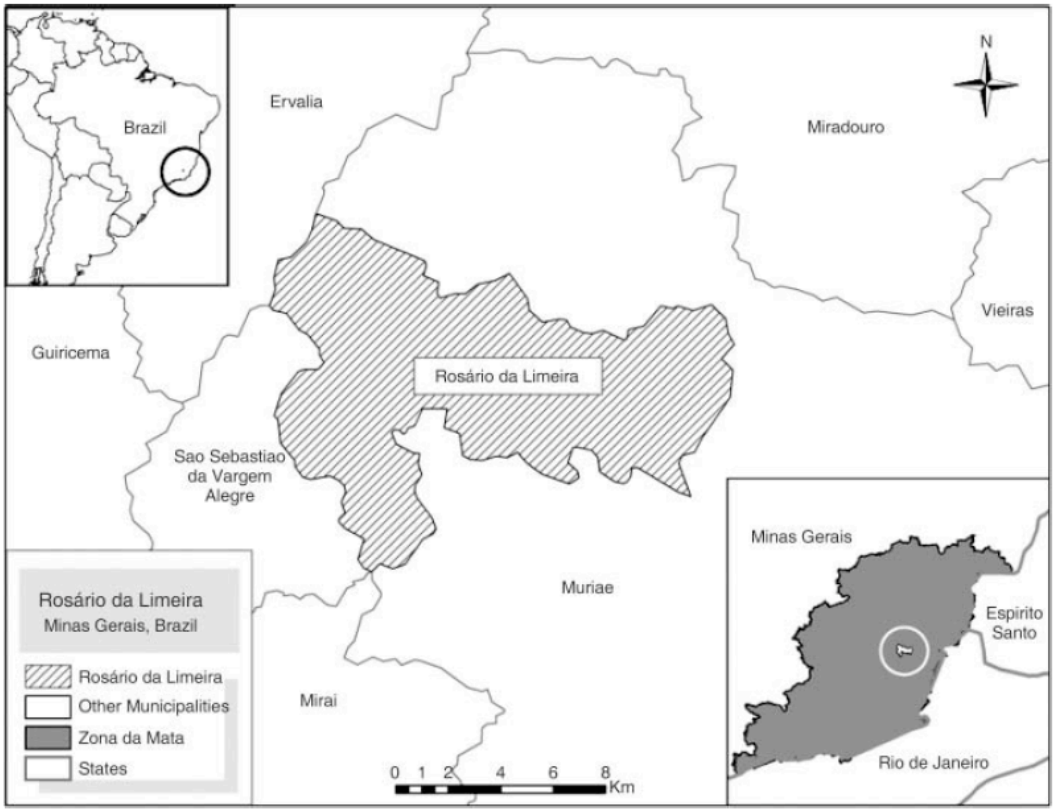

Figure 2: Rosário da Limeira, Minas Gerais, and surrounding areas (Watson and Achinelli, 2008, reprinted with permission from author)

Rosário de Limeira occupies a mountainous region in southeastern Minas Gerais known as the Serra do Brigadeiro Territory, named for the Brigadeiro mountain range at the northern edge of the Zona da Mata, about 290 km southeast of Belo Horizonte. The Serra do Brigadeiro Territory includes the 8 other municipalities as well as Rosário da Limeira. The total area of the territory is 2,944 km^2, which corresponds to about 8.4% of the total area of the Zona da Mata Mineira. The Serra contains several peaks up to 1,985

meters above sea level.

The municipality of Rosário da Limeria is home to a population of roughly 4,000 inhabitants in an area of 112km^2 with elevations ranging from 300m to 1500m. The region has a subtropical climate (Köppen Cwa) characterized by hot summers and heavy rainfall in the months of November, December and January (Tomé da Costa Mata, 1994). Average precipitation ranges from 1000 to 1200mm, and the soils are strongly acidic (Le Breton, 1998). Daily maximum temperatures in Rosário da Limeira range from 10˚C in the winter to 30˚C in the summer. The landscape is composed of fragments of primary forest located in inaccessible areas, patches of secondary forest on hilltops and around springs, coffee plantations, eucalyptus groves and pastures. About 75% of the area of the municipality is agropastoral land and 11.9% of the area is classified as forest, which includes primary and secondary growth. The largest continuous area of primary forest in this region is in the Serra do Brigadeiro State Park, covering approximately 15,000 hectares along the spine of the Brigadeiro mountain range (Achinelli, 2003).

As is the case for much of Minas, the communities of Rosário de Limeira are highly reliant on agriculture. It has been estimated that 90% of the population of Rosário da Limeira relies on agricultural activities as the principal source of income (Le Breton, 1998). The main products of this region are coffee, milk and beef (Le Breton, 1998). Over 60% of agricultural land in the municipality (1250 ha) is devoted to coffee plantations (IBGE, 2000). Beans are the second most important crop, in terms of hectares planted. Eucalyptus, sugar cane, limes, passion fruit and acerola are also important crops in the region. Tables 1 and 2 list some important socio-economic and land-cover data regarding this municipality.

Table 1: Socio-economic data for the municipality of Rosário da Limeira, Minas Gerais (IBGE, 2006)

Population in 2006	4,151
Residents ≥ 10 years of age with less than one year of formal schooling	540 (13%)
Residents earning ≤ 1 minimum salary	914 (22%)

Table 2: Land-cover data for the municipality of Rosário da Limeira, Minas Gerais (IBGE, 2006)

Area	112km^2
Agropastoral	8,359ha (74.6%)
Cropland	1,745ha
Coffee	700ha
Natural Pasture	5,011ha
Forest	1,337ha (11.9%)
Fuelwood produced in 2006	71m^3

The majority of land owners in this region are independent small-scale farmers who are descendents of the original pioneers in the area who settled the land under Brazil's law of *usucapío*, which conceded right of ownership to those who inhabited and used the land (Le Breton, 1998). Many of the original farms were of considerable size but because of the Brazilian law that requires equal allocation of land to offspring, a continuous cycle of fragmentation has occurred, and now most families cultivate coffee, eucalyptus and subsistence crops, and graze cattle on plots of 9 ha or smaller. These plots generally occupy marginal lands, often composed of steep slopes, which are less ideal for growing coffee. Only 10% of the rural population occupies farms of over 30 ha, which with current technology is the minimum size to support an economically viable family unit (Le Breton, 1998). Sixty percent of the total land area in this region is owned by 20% of the population and the most favorable 3% of the total land area are large-scale (100 ha or more) *fazendas*, whose owners often live outside the region and employ caretakers to maintain coffee, eucalyptus and cattle on the land (Watson and

Achinelli, 2008).

2.1.2 Fuelwood use in Rosário da Limeira

Households in the *Zona da Mata Mineira* obtain their fuelwood from three main sources: eucalyptus plantations, coffee fields and native forest. The native forests provided household energy to the original inhabitants of the *Zona da Mata* and have been the principal source of energy in this region until recent times. By the late 1700s, coffee had arrived in the region, and thrived in the nearly optimum growing climate (Watson and Achinelli, 2008). For centuries, coffee growers in Brazil have practiced a system of sun-grown coffee that requires the complete clearance of native vegetation from the land. Overtime, the term "forest zone" became increasingly inaccurate to describe the region, as plantations expanded across the *Zona da Mata Mineira*, replacing the native forests with monocultures of coffee. Between 1500 and the late 1990s Atlantic Forest cover in the *Zona da Mata Mineira* decreased from 48% to 2% (Watson and Achinelli, 2008). The resulting depletion of the region's thin and infertile rainforest soils has been exacerbated by erosion due to the practice of planting coffee vertically across steep hillsides. Soils in this region generally reach exhaustion after 15 years of cultivation, resulting in a relatively short productive lifespan of coffee trees. Low-producing bushes may be trimmed or cleared (this is generally done after approximately ten years of growth) and the wood can be burned as fuel. For households that have many hectares of coffee this is a viable source of fuel both for domestic purposes and for roasting coffee. However, coffee is not a reliable source of fuel for small landholders or for large industries, and energy for these enterprises was supplied from the native Atlantic forests, which were continuously being cleared for agricultural purposes. Large-scale clearing of native forest in the *Zona da Mata Mineira* has been halted only in the last decade, due to increased enforcement and the inaccessibility of many remaining fragments. The timber and fuelwood that had been supplied by native species is now being replaced by a genus of hardy exotic trees able to glean the few remaining nutrients from the weak rainforest soils after decades of coffee-growing and cattle grazing have

left them exhausted.

Eucalyptus is native to Australia and was introduced to Brazil in 1868 (CIB, 2008). The main species grown in Brazil are *Eucalyptus grandis*, *Eucalyptus camaldulensis*, *Eucalyptus saligna* and *Eucalyptus urophylla*. Hybrid species have also been developed (CIB, 2008). These Eucalyptus species are well adapted to growing in degraded soils and are well suited to the soils of the *Zona da Mata Mineira*, which have been severely depleted after centuries of coffee growing and ranching. In the late 1980s they lent the IEF over US$48M for eucalyptus planting programs that aimed to increase industrial wood production (primarily for the purpose of supplying charcoal for steel production) and reduce degradation of the native forests (WB, 1987). Additionally, this loan provided funds for the planting of about 40,000ha of eucalyptus woodlots on small and medium-sized farms. Since this time the IEF has provided eucalyptus to landowners but transportation of the seedlings was not provided by this agency, creating a bias against less affluent landowners. In the last decade, local municipalities have played a more active role in distributing eucalyptus seedlings to landowners who cannot provide their own transportation and eucalyptus plantations have become a widespread feature of the rural landscape in the *Zona da Mata Mineira* (Le Breton, 2008). Consequently, the use of eucalyptus as a domestic fuel has become commonplace.

Although some larger landowners produce eucalyptus fuelwood for industry, most landowners in the municipality of Rosário de Limeira produce and harvest fuelwood for domestic purposes only. Large amounts of fuelwood are required by landowners that roast their own coffee, but the majority of households in this region require energy principally for routine domestic activities such as lighting, cooking and heating bath water. According to a local official, nearly all households in this municipality have electricity due to a program, *Luz Para Todos*, implemented in 2003 by the federal government that provided funds for rural electrification. Over the last few years, the municipal government of Rosário da Limeira has used these funds to link any household within its jurisdiction that had not previously been connected to the electricity grid. Households in this region use electricity primarily for lighting and powering

electrical appliances such as TVs, radios, DVD players, and in some households, electric showers. Electric stoves are not used in this region. Instead, wood-burning stoves and gas stoves are used in ratios that vary from household to household. A minority of households use only wood or only gas. Most households use both depending on the type of cooking, the amount of time, the availability of fuelwood and the cost of gas. Households that do not have electric showers also rely on fuelwood to heat their bath water. Although winters in this region can be cold, energy is not used to heat homes. Nevertheless, the heat emitted when cooking with wood is seen as an additional benefit of using this fuel.

Because fuelwood use is often connected to status, which is often linked to income level, it is important to have an understanding of the economic status of the inhabitants of the villages identified for household surveys. According to Achinelli (2003), any study concerned with an aspect of poverty must first define what poverty means in that region. The most common definition of poverty is subsisting on $1 a day or less and by this criterion most of the households in the study area will be considered to be above the poverty line. Achinelli argues that many of these families can still be considered poor when poverty is defined more holistically as the lack of a 'secure and sustainable livelihood' and lack of 'protection against contingencies'. The rural households of Rosário da Limeria rely heavily on seasonal cash crops with low returns (depending on coffee and fertilizer prices). Because farmers in this region are often illiterate and dependent on the sale of coffee for cash, they have very little negotiating power in the market place. All family members must work in order to maintain subsistence and women in this region have a particularly high workload during the coffee-harvesting season when they must work in the home and in the field. Another factor contributing to the condition of poverty in this region is the remoteness of households, which results in residents obtaining less education and having unreliable access to information. The roads leading to three of the surveyed villages are mostly unpaved, adding to the isolated condition. Additionally, these households are not financially equipped to cope with disasters such as crop failure, accidents and fines

(Achinelli, 2003). Because of these factors, many of the households in this region can be considered to be poor.

2.2 Methods and Survey Design

A combination of methods was used to obtain both qualitative and quantitative data for this study. A household survey, semi-structured interviews, participant observation and focal follows were the primary methods for gathering information. However, before these tools could be refined for this particular case study, a conceptual structure was designed, organizing the research around the following issues:

1. Factors driving the use of fuelwood as primary source of domestic energy
2. Principal uses and sources of fuelwood
3. Local understanding of and adherence to Atlantic Forest policy

Subsequently, a set of questions that would seek to address these issues was identified. These questions were the following:

1. What are people's perceptions of fuelwood use?
2. What factors are driving fuelwood use and how does fuelwood use in these communities compare to the energy ladder?
3. What are people's perceptions about the forest, forest resources and forest policy?
4. What are the social, political and environmental implications of continued fuelwood use?
5. What are the implications of the lack of understanding and enforcement of Atlantic Forest policies?

Afterwards, a list of key informants and representative villages was drawn up. The key informants were identified based on their roles in the local government and communities and their likely understanding of the key issues. Most of these individuals were identified before data collection began, although a few were added during the

collection process. Representative villages were purposefully selected with the guidance of the Director and staff of Iracambi Atlantic Forest Research Center, a local NGO that has assisted with previous sustainable development studies in the region (Watson and Achinelli, 2008; Silveira, 2008; Achinelli, 2003). Although Iracambi advised on the choice of communities and suggested key informants, I sought to minimize the perception among participants that I was an Iracambi employee by arranging the majority of interviews myself and by introducing myself as an independent researcher. A plan of Key Informants and Representative Villages can be seen in Appendix A of this thesis. This plan was designed for a case study conducted by Robert E. Stake (Stake, 2005).

2.2.1 Semi-structured interviews

Nine semi-structured interviews were conducted with three types of informants: Iracambi staff, Forestry Officials and Municipal Officials. Questions varied depending on the informant, but the following key questions were always addressed:

- What are the factors that contribute to the use of fuelwood in the rural communities in this region?
- What are the biggest concerns for agricultural families in this region? If energy is not a major concern, why?
- How well do small agriculturalists understand AF Policy? Do you think this policy influences their domestic energy decisions?

During these interviews, snowball sampling was employed when appropriate. Occasionally, supplemental materials were gained during these interviews, such as a World Bank report on the topic of a Eucalyptus planting program, two theses written by students from the University of Viçosa, and a promotional poster published by the IEF regarding Legal Reserves and Permanent Protection Areas. Notes were coded for later use.

2.2.2 Household survey

Household survey instruments were the principal investigation tools applied for obtaining quantitative information in this study. The survey used in this study was approved by the Texas A&M Institutional Review Board (IRB) before being implemented. In accordance with the IRB Exempt Application for Use of Human Subjects in Research, survey participants were adult heads of household who were either involved with fuelwood collection and/or cooking. No form of coercion or payments was used to encourage participation. All participants were informed of the true purpose of the study and were ensured that their names would remain confidential by giving each household a code. No audiovisual recordings were made during household surveys.

The survey was performed in June and July of 2008 on 48 households in four villages in the municipality of Rosário de Limeira.

The villages chosen to participate in this study were selected because they were representative of small rural communities in the municipality and varied based on road access, industry and affluence. The number of families in these villages ranged from approximately 25 to 50 (Achinelli, 2003). Due to time and access constraints, participants from these villages were not selected through a rigorous random process. With the help of Iracambi employees, key individuals from each community were approached and surveys were conducted with these households. These individuals were asked to identify other residents of the village who might consider participating in the survey. In addition, respondents introduced the researcher to village members at community events such as church services or festivals. Approximately twelve households were surveyed in each community, most of which were selected by this snowball method, although in one less-accessible village I made cold calls at households. I specifically asked participants to recommend potential participants that spanned the socioeconomic continuum, focusing on finding non-landowning interviewees who would represent the lower socioeconomic status as this group is often underrepresented in fuelwood studies (Cooke *et al*, 2008). I also made sure to interview households representing the wealthiest strata in each community. These measures could

have lead to an oversampling of the poorest and wealthiest members of the communities, however, I did interview many middle class families as well and believe that I managed to sample evenly across the socioeconomic spectrum.

Although the snowball sampling design can be perceived as a last-resort strategy to be used only when other avenues have been exhausted, some authors have argued that it brings its own advantages. Noy (2008) writes that the snowball technique captures dynamic and processual social knowledge that would otherwise be difficult to obtain. Additionally, Noy (2008) claims that due to the use of natural social networks, the snowball approach touches on power relations between the researcher and informants and between the participants themselves. Additionally, in social situations where the researcher is an outsider, the snowball technique can lead to increased trust between the researcher and the informants, which in turn leads to increased reliability of the data. This is especially important for studies such as this where potentially illegal behavior is being discussed.

A mixed-method approach was used for the survey. Quantitative questionnaires relating to the livelihoods and fuelwood use and collection habits of family members were completed at each household. This quantitative information was supplemented through more in-depth interviews at my discretion. These interviews were important for gathering qualitative information related to the causes of behavior touched upon in the surveys. This mixed method strategy has become common in recent geographical research due to the renewed emphasis on finding explanations for behavioral patterns which cannot be explained by quantitative research alone (Winchester, 1999).

The household survey instrument was initially written in English and modeled after one used by Andrew Millington for research on fuelwood in the Bolivian Andes (Lazcano and Espinoza, 2001; Millington *et al*, 2002). The survey was then translated into Portuguese and some minor changes were made after the pilot study was conducted. The original English version is included in Appendix B of this chapter and the Portuguese version that was used for the study is included in Appendix C.

2.2.3 Issues with household surveys: Reflections on gaining trust of participants, association with an NGO, conducting field research with children and conducting interviews in a foreign language.

In many ways the household surveys are the pivotal component of this study, providing the location-specific fuelwood-use data called for by Cooke *et al* (2008), which can be used to gain a more accurate picture of the specific fuelwood related issues of this region. This was also the most difficult component of the research because it relied on villagers' willingness to participate in the study and provide honest responses. The main factors influencing willingness and honesty were participants' awareness of the illegality of native fuelwood-use and their perception of the NGO Iracambi. These two factors tended to leave participants wary and I found that the most useful tool I had to counter their distrust was the presence of my young son. I discuss these issues and their potential impact on the validity of my data in the paragraphs below.

The first practical challenge I confronted while gathering the household data was arranging the interviews. Although Iracambi endorsed my research and suggested key people to talk to, for the most part I was left to find the participants on my own. Only in one community did I have the help of a local resident to arrange many of the interviews. In two of the other communities I arranged interviews by attending local gatherings and asking people to schedule an interview with me. Approaching reserved people who I felt already eyed me with suspicion was often quite awkward and I found that one of my best resources both for arranging the interview and breaking the ice during the interviews was my eighteen-month-old son. I initially took him with me to community gatherings for maternal reasons, but soon realized that his presence made my job much easier. He inevitably attracted the attention of other children and women at the gathering and often women would approach me in order to talk about him. In such cases I would gradually steer our conversation towards the purpose of my visit to the region and then invite them to participate in the study. I do not believe that the acceptance of the participants was completely influenced by my son's presence, but I found that the initial approach of potential participants was much more relaxed for both parties when my son was with me.

Even after I had prearranged an interview, many participants seemed shy and slightly distrustful when I first arrived in their homes to conduct the survey. I believe that the main reason for participants' distrust was because in their minds the only potentially interesting issue surrounding fuelwood use was the illegal nature of its collection from native forests. Additionally, my association with Iracambi influenced their perceptions of me and my research and thereby the degree to which they trusted me. Sometimes it meant that a participant would trust me more, but often this association, along with the sensitive nature of native fuelwood use, led to an increased wariness on the part of the interviewee.

I was made particularly aware of this by one candid participant when we came to the question of which type of fuelwood she most often used. She smiled and said, "When people heard that you were coming to interview me, they all told me to tell you that I only use eucalyptus. But you can look in my woodpile and see that it is all native wood. I have no eucalyptus on my land; it's ridiculous to think that you would believe that I use eucalyptus! But people think that you are going to report us to the Forest Police." She was the most candid respondent in this regard, but others commented on the general suspicion surrounding my study and many participants questioned my interest in fuelwood use. While many participants were eager to share information, others were skeptical and guarded in their responses.

In these instances the situation was generally made more comfortable if my son was present as he would immediately begin to play with other children or animals, which eased the tension often created by my arrival. The initial strain overcome, I was generally able to engage the participant in a relaxed, conversational interview during which many respondents would open up and often be candid about their fuelwood use. Several households (14) were honest about relying completely on native species for fuelwood; others said they used natives as well as coffee and eucalyptus. I have a reasonable amount of confidence in these responses as there was no obvious reason for respondents to claim to be using native species if they were not. However, the majority of respondents (19) claimed to use only eucalyptus fuelwood, and these responses I have

less confidence in given the fear of some respondents that I would report native species use to the authorities. I do not believe that all 19 of these respondents were lying about their fuelwood use - in many of these cases the most obvious source of fuelwood was eucalyptus. Rather, it is probable that interviewees who used mostly used eucalyptus may have claimed to use only eucalyptus and that in reality there are more mixed-use households than the data shows. In general, I feel that although participants may have started the interview with suspicion, they were generally relaxed enough by the time I asked them about preferred type of fuelwood to give an honest answer, either because they didn't feel the need to lie, or they did not feel comfortable answering deceitfully.

In addition to breaking the ice and helping me to ease tension, the presence of my child allowed the participants to see me as a mother rather than just a researcher, as a real person having something in common with them, rather than a foreign scientist meddling in their affairs. For some people, the presence of my son would have made them feel more trustful towards me, or at least less comfortable lying to me. Although I would not have predicted that surveying rural households with a toddler in tow would have been the ideal way to conduct this type of research, I was soon very grateful that it had worked out this way.

Aside from my discussions with the Director of Iracambi, all surveys and interviews were conducted in Portuguese. I learned Portuguese by living in Brazil for four years and attending a Brazilian high school. I have maintained fluency in this language by returning frequently to Brazil and participating in study abroad and volunteer programs. I feel extremely comfortable conversing with Brazilians and am confident in my ability to make myself understood and comprehend most of what I hear and read. In instances where meaning is unclear, it is easy for me to ask the speaker to explain, or look a new word up in a dictionary. Consequently, I feel that my interpretation of the information I gathered during field research is accurate. However, I recognize the possibility that in some cases linguistic nuances may have lead to misinterpretations on my part, although I have done my best to avoid this.

One example of a misinterpretation caused by ambiguous language is the quote on page 91 of this thesis ("IBAMA *fala que não pode tirar nem pau seco").* Although I know that the most common English translations of the word "*pau*" would be "stick" or "wood" (it also has a sexual meaning in Brazilian slang which I only mention to demonstrate the complexity of the word), I initially interpreted it in this context as "tree". This made for the following translation of the sentence: "IBAMA says we can't even remove dead trees (from the forest)". Another fluent Portuguese speaker questioned this translation, rightly commenting the *pau* is not generally used to refer to a tree. However, from the context of my conversation with the woman quoted, I felt that she was referring to a tree rather than a stick. In order to settle the matter I e-mailed the Director of Iracambi, a native English speaker who has lived in the study region for 20 years, for his interpretation of this phrase. He said that in this case "pau" does not refer to a dry, standing tree, but specifically to a fallen tree. The difference between a tree that is dead but still standing and one that has fallen is subtle but important in the context of the forest code and its restrictions on resource access.

I provide this example to illustrate the complexity of interviewing in a foreign language, particularly on topics related to nature. However, despite this challenge I am confident that for the most part my interpretations of information have been accurate. If I had realized during the interview that my understanding of her use of the word "pau" was incorrect, I could easily have asked her to clarify. In many cases where I was uncertain as to the exact meaning of a word I was able to do this. It is unfortunate that in this particular case I was not able to contact the informant to clarify her meaning of the word, but I feel that I was able to ascertain it through other means. I am confident that additional misinterpretations have been few and that at least my general understanding of the information related to me, if not every specific, allows for an accurate translation of my data.

2.2.4 Participant observation

I used participant observation throughout my time in the field as a way to collect the details to add a real-life texture to the drier quantitative aspects of my data. Simply by living in a typical house and interacting with the rural villagers on a daily basis I was able to better understand many of their habits, customs, including the way they used and collected fuelwood. During my time in the field I operated as a co-head of my own rural household; my mother, son and I spent eight weeks together in a simple rural home on the top of a hill in the midst of the rural landscape. The house we stayed in had been home to ranch employees many years ago when Iracambi had been a working farm. Its structure was very similar to that of most houses in the region; plastered brick wall, glassless wooden window frames, and wooden rafters supporting a clay tile roof under which bats would often fly in the evenings. We had running water piped in from a nearby spring and our effluent was stored in an underground septic tank. We had electricity that powered an aging refrigerator, a light blub for each room, an electric shower and my laptop computer. And we had both a gas and wood burning stove, as is common in most rural households. As head of the household, I found myself making domestic energy decisions on a daily basis. Initially we experimented with cooking with wood and found it to be too time consuming for the types of food we usually prepared. We frequently struggled to even manage to light a fire with the often damp wood and found ourselves waiting until the local girl who cared for my son arrived in the morning to start our fire, often by using a plastic bag as kindling. So, we relied mostly on LPG for our cooking needs, but found ourselves using wood to heat water for washing diapers (by hand, as we washed all our clothes) in order to economize on the LPG, not so much due to it's cost, but it's weight. Our home was not directly accessible by car and we had to carry all our supplies up a very steep hill.

During the course of my time in the field I was able to observe nearly all phases of the coffee producing process as well as many phases of other food processing such as cheese and jellies. In nearly every household I surveyed I was offered coffee and sometimes cake. This provided an excellent opportunity to observe local coffee customs

and the variations between households. Some households would quickly heat a pot over the gas stove, others would place the kettle over the constantly smoldering embers of their wood stove, and others would pour my drink from a thermos that had been prepared in the morning and drained slowly by family members over the course of the day. Nearly all the cake I was offered had been baked in a gas oven; one of the main reasons that all households have gas –powered appliances is actually for baking rather than cooking. However, in at least three of the homes I visited the cake had been cooked in an iron pan set in the embers of a wood-burning stove with smoldering corn cobs set on the lid of the pan to cook the top of the cake. The women who baked using this method said they preferred the taste and found it easier to bake this way.

Throughout my eight weeks in rural Minas Gerais I had countless opportunities outside the household surveys for interaction with local people. My son befriended a neighbor boy whose home we frequently stopped at to buy eggs, and chase the hens and their chicks. I attended several village festivals and church services, shopped in the local stores, and spent two nights in the home of a rural family. All of these experiences enhanced my understanding of the livelihoods of my participants, the choices they made regarding domestic energy and the ways in which they interacted with their environment.

2.2.5 Focal follows

The *focal follow* is a research tool used to directly observe an activity of interest. In this case it was meant to be used to observe fuelwood collection in order to better understand the specific issues surrounding this topic; such as who collects the wood, what kind, how and from where? Unfortunately, due to the sensitive nature of the subject and the caution with which many respondents allowed themselves to be interviewed, I found it difficult to find willing focal follow participants. Most interviews started out with an air of tension, and even after this had subsided I was at pains to keep the interviewee relaxed and was very careful about what I said and how. During many of the interviews I could sense the participant's discomfort and knew that I would add to it and make them more cautious about their answers if I expressed too much interest in

their fuelwood gathering habits. Therefore, I only broached the subject of a focal follow with those participants that were very relaxed, chatty and eager to share information. Although there were many of this type of participant, not all of them used native species or collected fuelwood on a regular basis. Nevertheless, I ended up getting three commitments for focal follows, but two of them fell through, one of them because her house burned down the weekend before our scheduled meeting and she moved to a house in the city, the other because when I returned to do the follow he told me he didn't have time to do it anymore. In this last case I believe that after I did the interview with him, during which he was extremely open and interested in sharing his knowledge, someone must have warned him not to show me how he collected fuelwood as I would report him to the Forest Police.

I was able to conduct one focal follow with a very friendly and open household. Both the husband and wife were eager to share their knowledge and seemed genuinely pleased with my interest in their lives. They were unaware of the illegal nature of their fuelwood harvest and happily allowed me to follow the husband on a short excursion across their land to a patch of native forest where he cut down a dead tree for fuelwood. During the walk he pointed out native trees and discussed their uses. Upon our return he showed me how he sawed the tree into logs and let me have a try, then taught me how to use a native leaf to make a medicinal drink for headache relief, and finally he and his wife insisted that I stay for lunch and fed me a traditional regional meal, most of which was cooked on the wood stove, although the daughter fried some manioc on the gas stove. The whole experience was very educational for me and I felt that they enjoyed it as well. It would have been beneficial to conduct more of these focal follows, and if I had been in the area longer I probably would have been able to do so.

2.2.6 Summarization of methods

In conclusion, four research techniques were used to gather information in this study: semi-structured interviews, household surveys, participant obsrevation and focal follows. Each technique had its own challenges and provided a different perspective of fuelwood use. The bulk of data used for this study was gathered using the household surveys, supplemented by qualitative information from participant observation, interviews and focal follows. The quantitative data is statistically analyzed in the following chapter.

CHAPTER III

DESCRIPTIVE STATISTICS AND QUANTITATIVE ANALYSIS OF FUELWOOD USE

Many rural households in the *Zona da Mata Mineira* rely to varying degrees on wood as a source of domestic energy, despite the fact that most of them possess gas stoves. My analysis in this chapter focuses on the factors driving households in this region to use wood as a source of fuel. I aim to ascertain whether certain variables may be identified as predictors of fuelwood use in this region.

The most prominent hypothesis for explaining household energy decisions is the Energy Ladder. As explained in the introduction, this conceptual model predicts that the household transitions from biomass energy to higher density fuels are associated with a change in socioeconomic status, often related to income and/or education (Israel, 2002). Although this model has been criticized broadly, it remains the most commonly used framework for exploring fuelwood use. In this chapter I use the quantitative data collected from household surveys to statistically test the applicability of this model in the study region. The principal question I address is whether the variable "socioeconomic status" explains fuelwood use in the *Zona da Mata Mineira*.

Additionally, I will test the hypothesis that the amount of fuelwood available to a household affects the strength and direction of the relationship between socioeconomic status and fuelwood use. This hypothesis is supported by research reviewed by Hosier (2004), which found that rural fuel use is predicated mainly on fuel availability rather than other economic factors. My own observations during fieldwork supported this idea and will be discussed in detail.

3.1 Household Vignettes

Before discussing the descriptive statistics in detail, I will use this section to set the stage for the circumstances in which households made fuelwood-use decisions. Due to the heterogeneous nature of the sample population, several variables were found to have non-normal and non-homogenous distributions. Some variables exhibited a high degree of variation along certain portions of their continuum. In order to provide an informative picture of the differing circumstances confronted by households in this region and provide examples of the different factors that may play into the decision to use fuelwood, I will describe eight families that represent the different types of households found in this region. I have ranked these households in three categories that I have observed to make a difference in the household energy decisions: regular income, access to fuelwood and access to land. The rankings in each category range from "none" (as in no regular income, no access to land and no access to wood) to high (table 3).

Table 3: Example households in Rosário da Limeira, Minas Gerais with ranked categories

Code	Access to Land	Access to Wood	Regular Income
GR03	High	Med	Low
SP03	Med	Med	Med
SP02	High	High	High
SP07	Low	Med	High
SA04	Med	High	Med
SA10	Med	Low	Med
SP11	None	None	Low
SP13	None	Low	None

In all of the following household vignettes I report the amount of time each household spent collecting fuelwood, which is the independent variable used to test the energy ladder hypothesis in the regression. This variable is described in detail in section 3.3.

3.1.1 Landowning households

One common situation for a household in the study region is to own a small

farm, between one and thirty hectares, and receive one regular income, either as a pension, or from a salaried form of employment held by at least one member of the family, often an older child. An example of such a household is SP03, which occupies 21 ha of land, of which 15ha are pasture. There are three hectares of native forest on the property, one hectare of coffee and one of eucalyptus. The couple is in their early to mid 40s and both husband and wife were educated only until the 4th grade. Their primary income is from coffee, but their two oldest sons, who reside at home, have salaried jobs (one in the state police force, and one as a miner) and contribute to the family income. However, the family receives the *Bolsa Familia*, indicating that these funds are not included in the official family income. Both sons have completed high school, and one attends classes at the community college in Muriaé (a regional capital, about an hour away by bus from Rosário da Limeria). The family also has two daughters, a 17-year old in high school, and an 11-year old in 5th grade.

The female head of this household uses wood to cook both lunch and dinner, and uses LPG to heat coffee and to bake. She uses mostly coffee and eucalyptus wood, and said that it is very difficult to find good fuelwood in the native forest. Usually the father and oldest daughter gather the wood, and spend about half a day, once a month, collecting wood in an ox cart from the coffee fields or eucalyptus plantations on the property. This averages out to 16 minutes per day that this household spends collecting wood. They use 13kg of LPG every three months.

Another variation of this situation is small landowners who receive no regular monthly income other than the *Bolsa Familia*. Instead, these households receive the majority of their income from the annual sale of coffee. The amount obtained varies from household to household depending on a variety of factors including the market price, cost of inputs, amount of coffee produced, the cost of toasting, and whether the coffee they sold was grown on their own land rather than sharecropping. These households face the challenge of rationing this coffee income throughout the year. Generally, members of these households will find ways to supplement this income, often by doing day labor on another property, especially during the coffee season, or by selling

other products such as milk and vegetables. None of these forms of income is regular, and for that reason, such households are restricted in their ability to regularly purchase goods.

An example of a household in this situation is GR03. This family is made up of a middle-aged couple with four children living at home, ranging from age 10 to 19. They live on 27ha, divided informally between eight brothers, one of whom is the male head of the GR03 household. According to Brazilian law, the property should have been divided in eight even parcels, but only three of the brothers actually live on the land and use it, and they have an understanding between themselves that allows them to share most of the resources on the property, although each of the three households has their own homegarden. In addition to their private homegarden, GR03 has 4,000 coffee bushes for which this household is solely responsible, although relatives will sometimes help out during the harvest.

The male household head of GR03 has lived on the property for around 40 years. When he was growing up, there was no bus running students to the nearest high school (in Rosário da Limeira, about 12 km away). Consequently, he studied only until the 4th grade. His wife, who is younger, studied only until the 2nd grade, perhaps due to a combination of transportation difficulty and the need for her to work at home. Their 19 year-old son completed middle school (8th grade) and now works as a day laborer. Their three daughters are still in school. The oldest one seems set to go on to high school and has a better chance than her parents due to the regular bus service that now takes students from their village to the high school in Rosário da Limeira.

Other than coffee, this household raises a variety of livestock including chickens, pigs, ducks and a horse. They sell meat and vegetables to the volunteer center at Iracambi, which brings in some income. All family members occasionally work as coffee pickers during the season, thereby further supplementing the income from their coffee and other crops.

Among the shared resources on their property, GR03 has access to three hectares of native forest, and one-and-a-half hectares of eucalyptus. GR03 relies heavily on

fuelwood for cooking; the wife says she generally lights a fire in the stove in the morning and keeps it burning the entire day. She never cooks with gas, although she has a gas stove that she laughingly referred to as a decoration. GR03 have used eucalyptus wood for the last 20 years. Before that they used native species, but switched to eucalyptus as it became the most convenient source. Native forest near their home had mostly been cleared and eucalyptus had been planted nearby. Also, their awareness of the importance of forest conservation had increased in part due to the influence of Iracambi, which has been particularly active within this community, but also due to the location of this community within the buffer zone of the Brigadeiro State Park. The wife and children in this household are generally the ones who gather the wood, spending about two hours once a week collecting wood from the eucalyptus grove. This results in an average of 34.29 minutes per day, double the average, spent by the household on fuelwood collection.

Two other types of landowners were observed in my study sample. Both of these were affluent, but varied in the amount of land they owned. SP02 was the largest landowner that I interviewed, with 64ha, most of which is in pasture. He has a couple hectares of coffee, five hectares of native forest and 1ha of eucalyptus, planted in a more accessible location than the native forest. Both the husband and wife are in their early 60s and still work on the land and in the home. The husband studied until the 2nd grade and the wife received no formal education. They had three daughters, all grown, married and settled in the same community. Of the four communities surveyed, this one is the closest to Rosário da Limeira (4km) and, not coincidentally, the most affluent and least forested. This village is often referred to by the name of one of the most established and affluent families in the village. The wife in household SP02 is a daughter of this family.

The major sources of income for this household are cattle, milk, coffee and eucalyptus. For the last 10 years they have been regularly selling eucalyptus wood to a buyer who sells to a dairy product producer that uses wood in the processing of its products. One indication of their affluence is that this household was able to pay to have electricity lines from the city extended to their house, which allowed them to have access

to electricity more than a decade earlier than most families in the region.

This household uses a combination of wood and gas for their cooking needs. The wife uses wood primarily to cook lunch, while she uses gas to heat water for coffee and cook dinner. A 13kg canister of gas lasts this household three months. When cooking with wood, she uses eucalyptus, which she has used for the last 30 years because it has been more convenient to gather than native forest, which has become increasingly scarce on their property. The five remaining hectares have been established as a Legal Reserve and a Permanent Protection Area, in accordance with AF Policy. This was one of the only surveyed households to have a registered RL and APP. The husband gathers eucalyptus wood every 75 days or so, and their household spends an average of 2.4 minutes a day on fuelwood collection.

A different type of affluent landholder in the region is more typical of a younger generation, the children of the larger landowners such as SP02, who continue to live in rural areas but do not make their living on the land. An example of this type of household is SP07. In this household, both the husband and wife completed high school and are employed in positions in the local government. The father of this household is a son of the village patriarch (after whom the village is nicknamed), and the wife is a daughter of SP02. They are both in their 40s and have two daughters, both of whom also completed high school. They own only three hectares of land, mostly composed of pasture, upon which they recently constructed a new home in a modern style, which stands out among the more traditional homes in the community. It is the only two-story house in any of the nearby rural communities and the outside is painted a light pink. Inside, the eleven rooms are all fully finished in ceramic tile, as opposed to cement or dirt floors, and all the rooms have ceilings, as opposed to just the roof tiles. In a middle class district in any Brazilian city, even Rosário da Limeira, this home would not stand out, but in its current surroundings it certainly does.

This type of household lives an urban lifestyle while maintaining ties to its rural heritage. The members of this household rely on motorized vehicles and cell phones, but also keep some livestock, including a milk cow, and, when time allows, enjoy a meal

prepared on a wood-burning stove. The mother of this household explained that she only cooks dinner at home and reheats the leftovers for lunch the next day at the office. At home, she cooks with both gas and wood, depending on what time she gets home from work, and if there is wood available. She goes through a 13kg can of gas every two months. When she uses wood it is eucalyptus that she and her husband gather when they feel like a wood-cooked meal. Owing to the sporadic nature of their wood gathering, they were unable to estimate a woodfuel collecting frequency and consequently I was unable to estimate the time that this household dedicates to gathering wood. However, judging from their responses, I would guess that it is perhaps half-an-hour once every week or so, which would work out to be less than four minutes a day, considerably less than the mean.

3.1.2 Non-landowning households

Although most households in this region are established on land that belongs to them or someone in their immediate family, many families do not own land, perhaps because they have not yet inherited their parent's land, or because their parents do not have any land. Commonly, members of these households are employed as caretakers by large landowners and live on the main property with access to all its resources. One example of this type of household is SA06. This household is located in one of the more remote communities, about 12km from the main city. Much of the land in this community is owned by large landowners who live in other parts of the state and employ caretakers to look after their properties. The husband of SA06 is the principal caretaker on a 360 ha ranch and the wife sometimes works as a day laborer on the property. They are bothin their early 20s, both high school graduates and had no children at the time of the interview. The majority of the land on the ranch is pasture, but the owner has preserved 116 ha of native forest and has planted over a hectare of eucalyptus. The ranch also has about nine hectares of coffee. SA06, as well as the other families employed by the owner, have access to many of the resources on the property, such as water and fuelwood. The wife of SA06 uses wood to cook lunch every day but other

than that uses gas for other cooking needs. She mostly uses coffee wood, which they both gather from the coffee fields two or three times a month. Their time spent collecting fuelwood was calculated to be 12 minutes per day per household. One 13kg canister of gas lasts them about two months.

The resources available to a caretaker vary depending on how the owner decides to use the land. On a nearby ranch, in the same community as SA06, I interviewed what turned out to be the only household in my data set that regularly purchases fuelwood. This household, SA10, is situated on a 300 ha ranch, which the husband is employed to manage. However, this property has no forest on it, either native or eucalyptus. Instead, the owner has converted almost the entire property to pasture, except for 50 ha of coffee. This household does not use the coffee plantation on the property as a source of fuelwood, perhaps because it is not large enough to supply a regular stock of dead wood. Instead, each month, they purchase wood. Sometimes they buy wood from the sawmill in Limeira, but they prefer to purchase coffee wood from their neighbors, including SA04, when it is available. They pay about R$55 per truckload. The wife in this household uses wood to cook both lunch and dinner, and relies on gas to heat water for coffee and to bake. A 13kg canister of gas lasts this household three months.

The husband in this household, who is 40 and completed middle school, is currently the only household member earning a regular salary, and this household receives the *Bolsa Familia*. The wife has an injury and cannot do hard physical labor, but she works around the house. She is in her mid-30s and studied until the 2nd grade. They are responsible for six children ranging from age seven to eighteen. The 18-year old is the wife's younger brother who is just now finishing middle school and will most likely start working soon.

Not all caretakers interviewed were employed by large landowners. One household, SP11, was employed to care for the cattle of a landowner but did not inhabit a large piece of land. Instead, they lived on a small property composed of three pastured hectares. The husband and wife in this household were both young (in their early 30s and 20s respectively) and neither had completed middle school. They moved to this

location from another part of the state to work for this landowner. They had one 2-year old son. This was the only household I interviewed that used no fuelwood at all. They relied exclusively on gas for all cooking needs. The wife explained that she preferred to cook with gas because it was faster and cleaner, and because they had no fuelwood. A 13kg canister of gas lasted them a month and a half.

In this same community I interviewed a household whose circumstances were similar to SP11, but varied in subtle yet important ways. The members of this household, SP13 (mentioned above when demonstrating the effect that available fuelwood has on the relationship between socioeconomic status and time spent collecting fuelwood), were not employed by a landowner. Instead, they rented three hectares from a landowner and were responsible for managing the 8,000 coffee bushes on the property. Rather than being paid a salary for this work, they received 40% of the proceeds, from which they would have to purchase any materials needed for the following year's crop, such as fertilizer. The remainder of the property was pasture and a very small bit of forest. The wood supply on this land was not nearly enough to furnish the needs of this family, composed of a 45-year old father with no education, a 37-year old mother who studied until the 2nd grade, and five children ranging in age from two to 18. The mother of SP13 was one of the only interviewees to express concern over the supply of fuelwood. She explained that when fuelwood was needed they had to travel over one hour in their horse-cart to their employer's other property that had native forest on it. They made this journey every week, and as a household spent an average of 42.86 minutes a day, well over twice the mean, collecting fuelwood. Even so, they still relied heavily on gas, using 13kgs of LPG every two and a half months. Funds from the *Bolsa Familia* were used to help purchase the LPG.

In addition to not having access to fuelwood on the property they inhabited, SP13 has another thing in common with SP11. In a region where many people are related, and many households occupy land inherited from family, these two households were both outsiders. SP11 did not go into detail about why they moved from their hometown, other than to find work. However, the wife of SP13 alluded to a messy divorce and the

need to relocate with her children and new husband.

As these vignettes demonstrate, households in this region confront varying interactions between access to land, access to wood and regular income, factors that may influence the amount of time households dedicate to fuelwood collection. This helps to explain the heterogeneity of the population and the resulting heteroskedastic distribution of some variables, including Time Spent Collecting Fuelwood.

3.1.3 Differences in access to fuelwood

In this section I provide two final vignettes describing field observations that led to my hypothesis that the amount of fuelwood available to a household affects the strength and direction of the relationship between socioeconomic status and fuelwood use.

SP13 was described in the previous section, but for the purpose of this discussion it is important to recall that this household is located on a small property (three hectares) that is not owned by the household and has very little available fuelwood. What is interesting about this household is that despite their low income, they rely heavily on LPG as a domestic fuel source, going through a 13kg of gas in two-and-a-half months, which is faster than the average household in the region (4 months). This household receives no regular income other than conditional cash transfers from the government (*Bolsa Familia*), which is capped at R$95 per month. Every two months or so, SP13 must spend over a third of this amount (R$35) on a canister of gas. Because of the considerable expense of LPG, the preferred fuel for this household is wood, but as the wife explained to me during the interview, for this household, "*lenha é a coisa mais dificil*", or "fuelwood is the most difficult thing". She was one of the only interviewees mentioned fuelwood scarcity as a concern. There is little wood on the land occupied by SP13, and, as they are new to the region, they have not formed relationships with their neighbors that would allow them to gather wood on nearby properties. Instead, they travel over an hour each way to another property owned by the landowner for whom they work, where they are permitted to gather wood. So, despite their regular use of gas,

this household also devotes a lot of time to the collection of fuelwood. Due to the distance they must travel, their average time spent collecting fuelwood is high (almost 43 minute per day).

The time that SP13 dedicates to the collection of fuelwood is much higher than the time spent by another household in similar circumstances. SG01 does not receive the *Bolsa Famila*. Otherwise, the two households are comparable, in that they are of similar size and neither of them owns their own land. However, the male head of SG01 is employed as a caretaker on a large property and therefore has access to over 20 ha of fuelwood. As a result, SG01 spends an average of only 2.67 minutes per day collecting fuelwood and uses much less gas than SP13, going through only one canister per year. Every two or three months SG01 dedicates a few hours to the collection of fuelwood. It does not take the household long because wood is readily available and they use their employer's vehicle rather than a horse-cart to quickly reach the most appropriate fuelwood collection location on the property.

These two examples illustrate how the amount of fuelwood readily available to a household plays into the choices they make regarding domestic energy. After making these observations, I suspected that available fuelwood could have a moderating effect on the relationship between socioeconomic status and time spent collecting fuelwood. A moderator variable is one that affects the strength and direction of the relationship between the independent and dependent variables (Baron and Kenny, 1986). I hypothesized that for those households with low available fuelwood, the relationship between socioeconomic status and fuelwood use would not be as strong as for those households with medium and high access to fuelwood. This hypothesis was tested as part of the regression analysis and the results are discussed later in this chapter.

3.2 Descriptive Statistics

In this section I present the descriptive statistics of the household survey data to enable a better understanding of the particular details of fuelwood use in this region, as well as to offer a general description of its inhabitants and their circumstances.

Household size in this study ranged from two to eleven members, with an average of four (Table 4). Seventy-three percent of participants owned land, with size of landholding ranging from three to 64 ha, with a mean of 16.6 ha. Eleven surveyed households did not own land, but had regular access to plots of land ranging from one hectare to 500ha, with a mean of 154.5ha. Many of these informants were employed as caretakers for landowners. In these cases, caretakers had access to most of the natural resources on the land to supply daily household needs such as water, pasture for animals, and wood for fuel, construction and carpentry. But regular access to such large amounts of land was not common. Fifty percent of all households sampled had access to 15 ha of land or less (Figure 3), and much of this land had been cleared for pasture, so that in some cases households had no access to fuelwood on the land they inhabited (Figure 4). Observations in the field suggested that an important variable in fuelwood use is the amount of fuelwood available to households, which varies depending on other factors such as land-use choices and means of access to forest (ownership or usufruct). When all categories of wood sources were included (native forest, eucalyptus and coffee), the hectares of potential fuelwood immediately available to participants (by being located on land that they either owned or occupied) ranged from zero to 126.8 ha, with a mean of 12 ha and a mode of one hectare. A slightly negative correlation between available fuelwood and time spent collecting fuelwood was found, but was not statistically significant. However, observation supports the idea that the considerable variation in fuelwood availability affects the amount of time a household spends collecting wood.

The type of wood used for fuel (along with the types of woody vegetation on the property) varied among households. The most commonly cited type of fuelwood used

was eucalyptus, followed by native species and then coffee (Table 5). This result is different from the Botrel *et al* (2006) study, which found that few households used eucalyptus as a substitute for native fuelwood. Informants reported that 87% of properties contained some native forest, and that 75% of properties had some eucalyptus.

Table 4: Number of people per household in sample of Rosário da Limeira, Minas Gerais

Number of People per Household	Frequency	Percent
2	9	18.8
3	20	41.7
4	8	16.7
5	5	10.4
6	3	6.2
7	1	2.1
8	1	2.1
11	1	2.1
Total	48	100

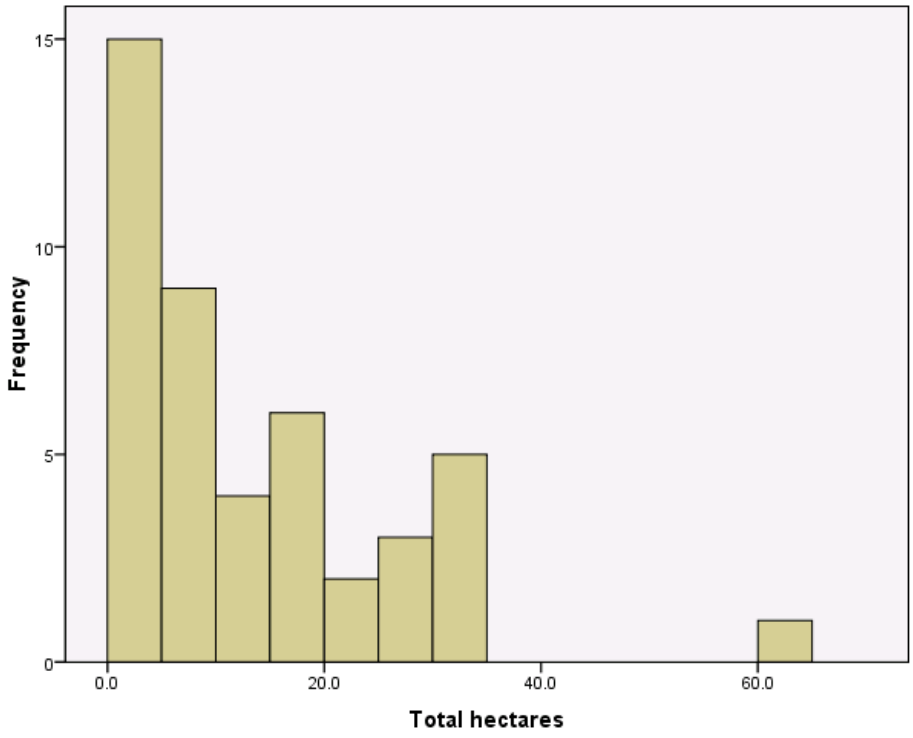

Figure 3: Size of property (owned and/or lived on) in sample of Rosário da Limeira, Minas Gerais

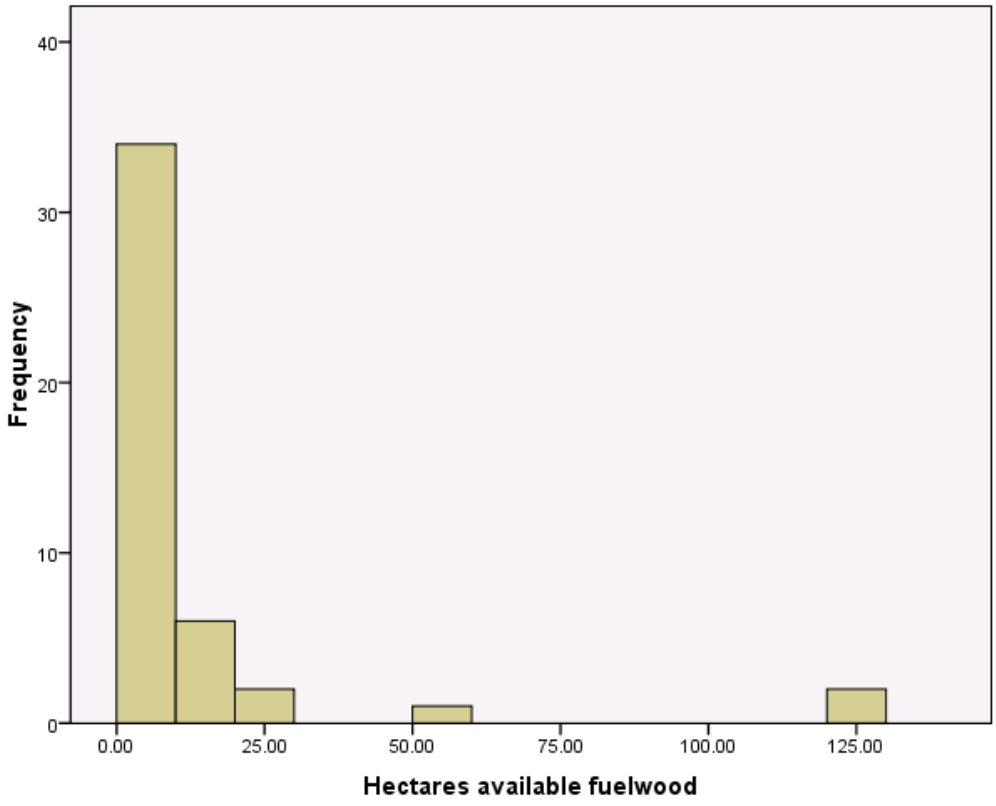

Figure 4: Available woodland as source of fuelwood in sample of Rosário da Limeira, Minas Gerais

The area of native forest on a property ranged from zero to 116 ha (Figure 5), although only two participants lived on a property with more than 20 ha of native forest. These participants were both caretakers for the same large property owner, who, unlike many neighboring large-property owners, elected to preserve much of his native forest rather than convert it to pasture or eucalyptus. Among the other participants, the average forest fragment size on the property was 2.9 ha. The area of eucalyptus held by households surveyed ranged from zero to 15 ha with a mean of 1.4 ha, although only three participants lived on land with more than five hectares of eucalyptus (Figure 6). The median value for size of eucalyptus grove was half a hectare. Just over 70% of households surveyed had at least some coffee on their property, although in many cases

this was only about half a hectare and would not have provided a reliable supply of fuelwood (Figure 7).

Nearly every household surveyed used fuelwood to some extent. Only one of the 48 households surveyed used no fuelwood at all (SP11), a result that is consistent with what Botrel *et al* (2006) observed. All other households used fuelwood at least occasionally. Five main uses of wood were identified: heating coffee, cooking lunch, cooking dinner, baking and heating bath water. Table 10 shows the frequency distribution of these uses.

Table 5: Types of fuelwood used by households in sample of Rosário da Limeira, Minas Gerais

Type of fuelwood	Frequency	Percent
Eucalyptus	19	39.6
Coffee	3	6.2
Native species	14	29.2
Eucalyptus and Coffee	9	18.8
Eucalyptus and Natives	1	2.1
Natives and Coffee	2	4.2

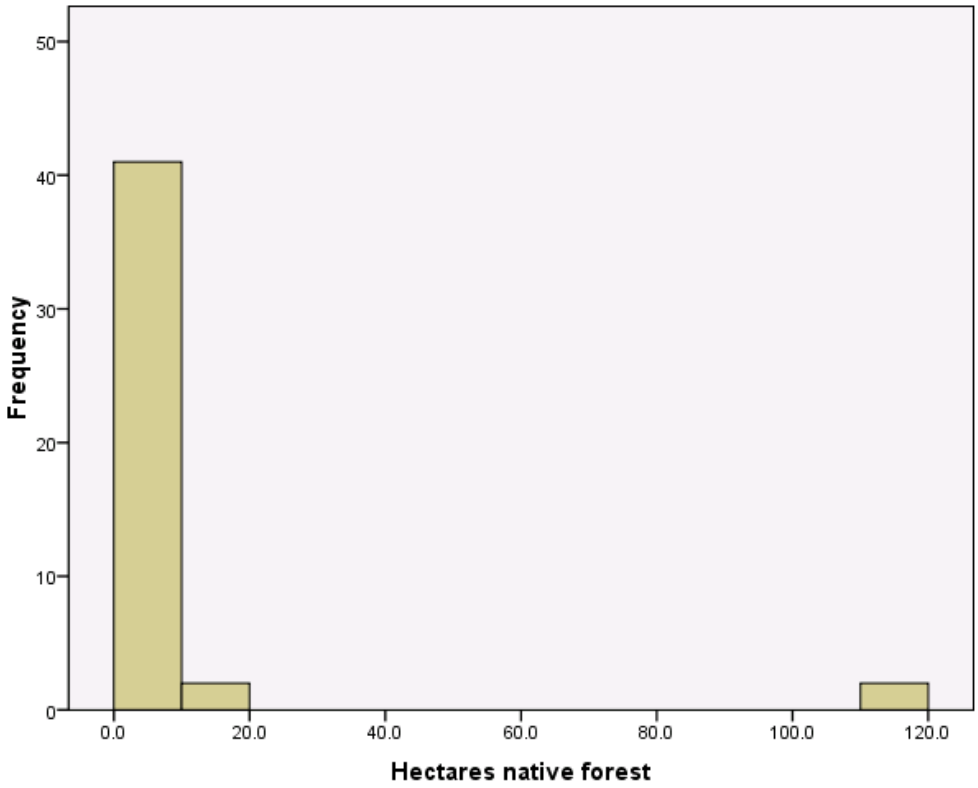

Figure 5: Area of native forest on properties in sample of Rosário da Limeira, Minas Gerais

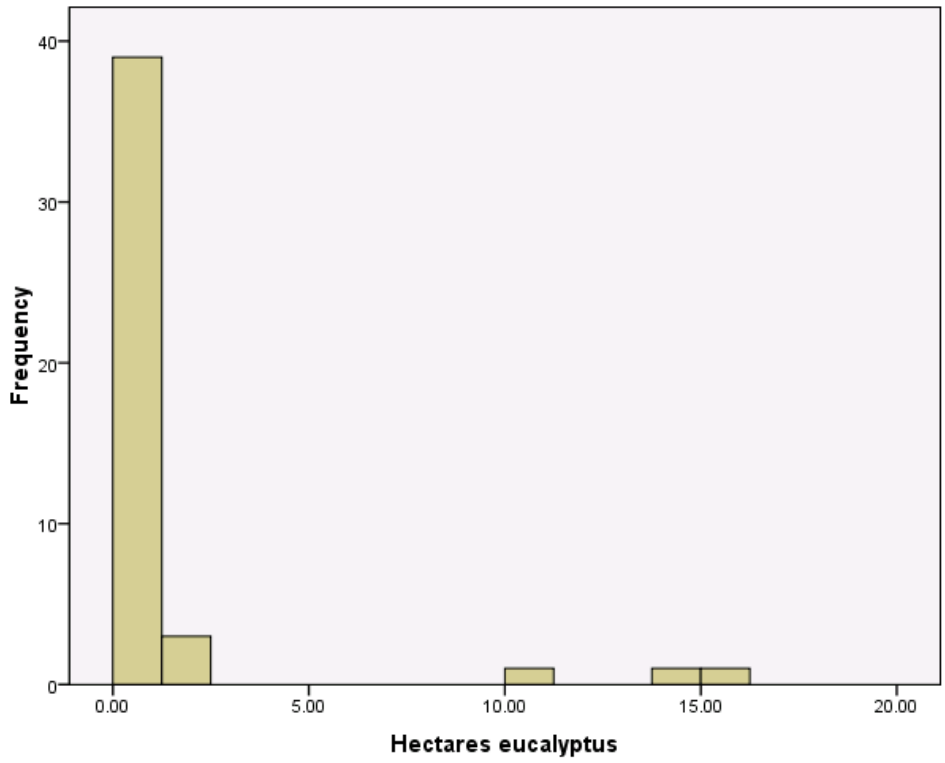

Figure 6: Eucalyptus grove size in sample of Rosário da Limeira, Minas Gerais

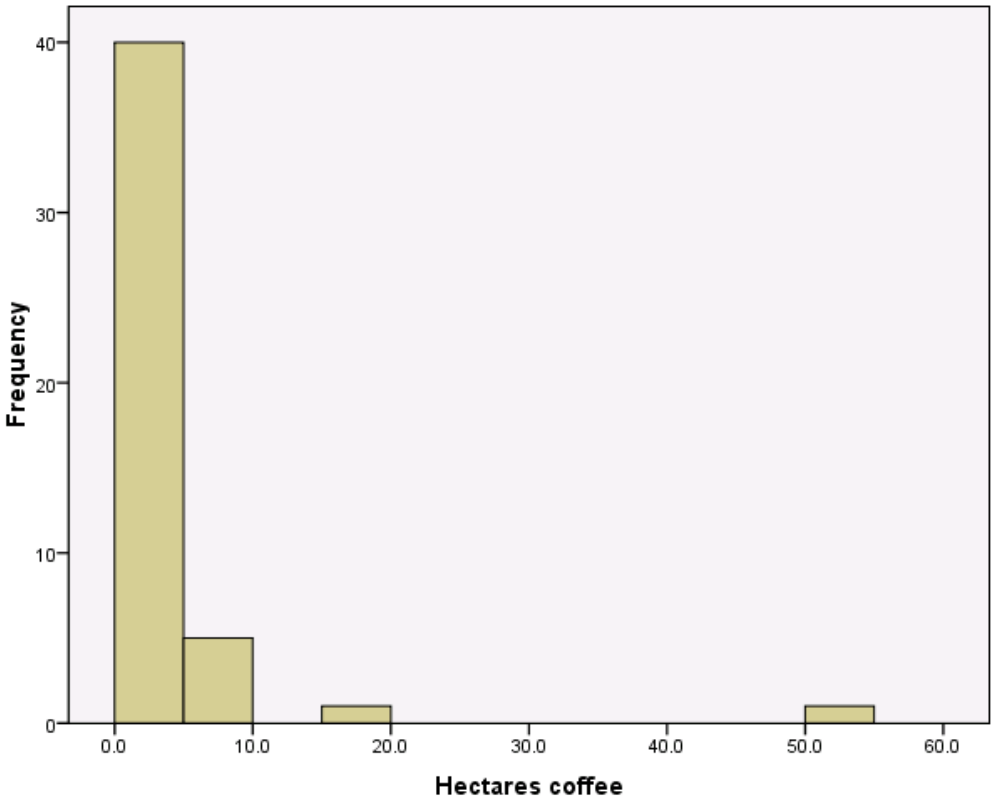

Figure 7: Coffee plantation size in sample of Rosário da Limeira, Minas Gerais

Households used fuelwood for different purposes and to differing degrees. Very few households used no wood at all, and very few used wood for all five purposes. Most households used wood for one or two purposes (Figure 8). Of those that used wood for only one purpose, 76.9% used it to cook lunch (Table 6). For households that used wood for two purposes, 76.5% used it for cooking lunch and cooking dinner. Households often use more wood for lunch preparation than for dinner. Lunch is the most important meal of the day; both in calorific and social terms, and in rural Minas Gerais it is often the only one in which food is specially cooked. Most informants devoted more time and effort in the preparation of the midday meal than they devoted to either the morning or evening meals. Often, the gas stove was used to heat coffee for breakfast and reheat

leftovers for dinner, because it is quicker than the wood-burning option. Alternatively, household members may heat their coffee on the wood-fired stove that had been lit to prepare food for lunch. Depending on how the day was to be spent by the wife, lunch was either prepared in the morning and taken out to the fields during coffee harvesting season, or prepared later in the day for household members to eat at home.

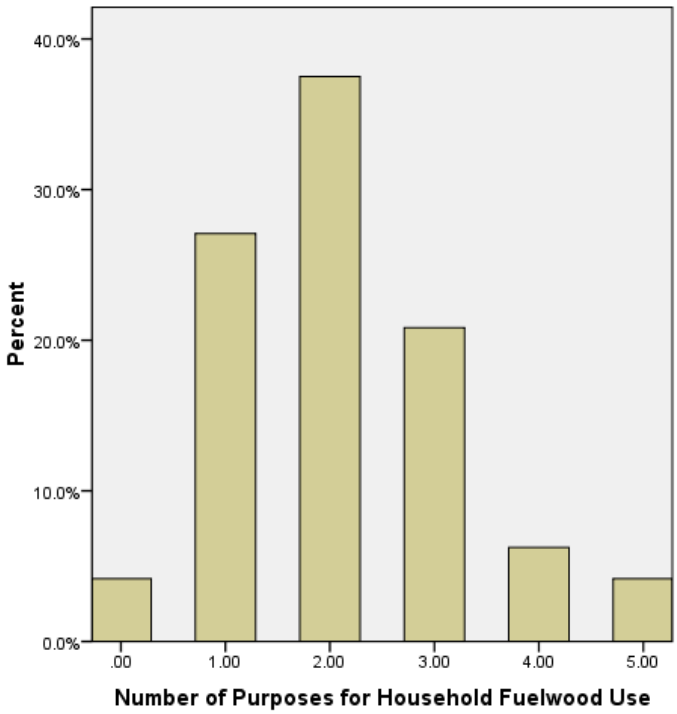

Figure 8: Number of fuelwood uses in a household in sample of Rosário da Limeira, Minas Gerais

Table 6: Frequency distribution of fuels used for domestic purposes in sample of Rosário da Limeira, Minas Gerais

	Heating Coffee	**Cooking Lunch**	**Cooking Dinner**	**Baking**	**Heating Water**
Fuel Type	%	%	%	%	%
Wood	20.8	89.6	66.7	6.1	25
Gas/ Electricity	72.9	10.4	33.3	91.5	72.9
Both	6.2	0	0	2.1	2.1

Beans are a key component to most lunches and many informants expressed the view that beans cooked over wood taste better than gas-cooked beans. The wood-cooked flavor is a key element of many traditional dishes in Minas Gerais and in any Mineiro restaraunt most food will have been prepared over wood stoves, or at least presented that way. This may help to explain why most households surveyed continue to use wood as fuel, even if it is only to cook one meal a day. Even in households where women work outside the home and tend to rely on gas, wood is the preferred fuel to use on special occasions. One interviewee who was part of a wealthy family that had just built a modern home proudly showed me the wood burning stove that she had built with a special cubby to hold wood. Even though the majority of her cooking was done on the gas stove, the ability to cook with wood was essential to maintain traditional aspects of her family's lifestyle and the wood-burning stove was still an important feature in her modern home.

Participants gave several answers to the question "what is your favorite fuel for cooking and why?" (Figure 9). The traditional aspect of wood-cooked food was an important factor and was the most frequently cited reason for using wood. Most of the participants had first learned to cook on wood, and found it easier and more convenient. While it personally took me several minutes to get a fire going, especially on a wet day, and many minutes more to get water to boil, I observed that many women could light a fire in seconds and quickly cook a hearty meal over it. Additionally, many women commented that wood-cooked food stayed warm for longer, while food cooked on gas lost its heat quickly. The taste of wood-cooked food was the second most frequent explanation for using wood. Wood-cooked food was widely said to taste much better, and is an important part of the cultural menu.

The cost of fuel also played a role in household decisions to use wood. Only one of the 47 wood-using respondents regularly purchased wood. The other households gathered most of their own wood, either from their own land or the land of their employer. The only other fuel option for cooking is LPG, which is sold in 13kg gas canisters in grocery stores in the small city of Rosário da Limeira, which is the capital of

the municipality and is 4 to 15 km from the villages in this study. Another town, Belizário, is also about 4 to 15 km away from these villages and also has a store that sells canisters of gas.

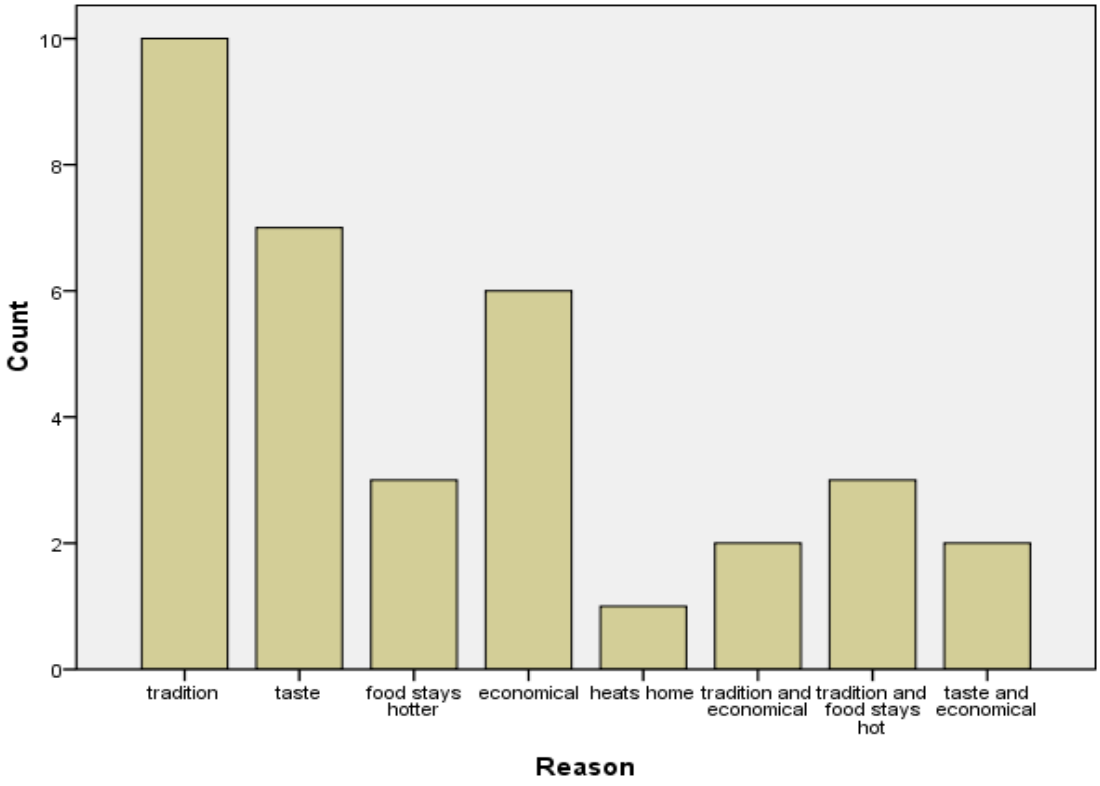

Figure 9: Reasons given for using fuelwood by households in sample of Rosário da Limeira, Minas Gerais

There are two important costs associated with the purchase of gas. At the time of the study the cost of a 13kg canister of LPG was R$30 (about US$16.40). Although the monthly income of these households was not calculated in this study, for those that participate in the *Bolsa Familia* program, their only regular source of income may be a monthly cash transfer from the government that is at most R$95, in which case the cost of a canister of gas would be nearly a third of this payment. For other households that

have one or more members employed outside the home, they may earn the minimum salary of R$465 per month. Because many households receive little or no regular cash income, the cost of LPG can be significant enough to cause households to avoid this expenditure.

In addition to the cost of the gas itself, the cost of transporting the heavy gas canister is also important. For households with no motorized transportation, they must travel to town in their horse-carts, which can take many hours. Others may go to town by bus and pay a taxi another R$30 to transport their groceries and gas back to their home. Even for households with motorcycles and cars, the cost of gasoline adds to the cost of LPG. Despite these costs, all but three of the surveyed households purchased gas regularly, some every month, some every six months, some once a year (Table 7). However, wood is understood by research participants as a more affordable and often more convenient option. The cost of time spent collecting wood was not seen as a financial burden. Often household members gathered wood on the way home from work, or as they worked in the coffee fields. Other families devoted a few weekends a year to gathering wood, thereby limiting the days that were imposed upon by this chore.

Table 7: Duration of one 13kg canister of LPG in households in sample of Rosário da Limeira, Minas Gerais

Number of months	Frequency	Percent	Cumulative Percent
1	5	10.4	11.1
1.5	5	10.4	22.2
2	7	14.6	37.8
3	8	16.7	55.6
4	7	14.6	71.1
5	2	4.2	75.6
6	5	10.4	86.7
7	2	4.2	91.1
10	1	2.1	93.3
12	3	6.2	100.0

Trade in fuelwood was not found to be common in the study region. Most participants gathered their own fuelwood, although one household purchased coffee wood from a neighbor. Only 6.2% of participants sold fuelwood, and most of those sold fuelwood only occasionally. All fuelwood harvested for selling was from eucalyptus plantations and most of this was sold to buyers for local industries such as a dairy product producer that required large amounts of fuel to process milk.

The individuals gathering the wood varied from household to household but men were found to be primarily responsible for gathering wood, either alone, with their wives or with their children (Figure 10). This result differs from Botrel et al's (2006) observations that it was typically women who conducted this task. Fuelwood collection in this region is measured in armloads, backloads or cartloads, therefore many respondents were not able to estimate the volume of wood gathered per month, but those who did estimated an average of 1.5m^3.

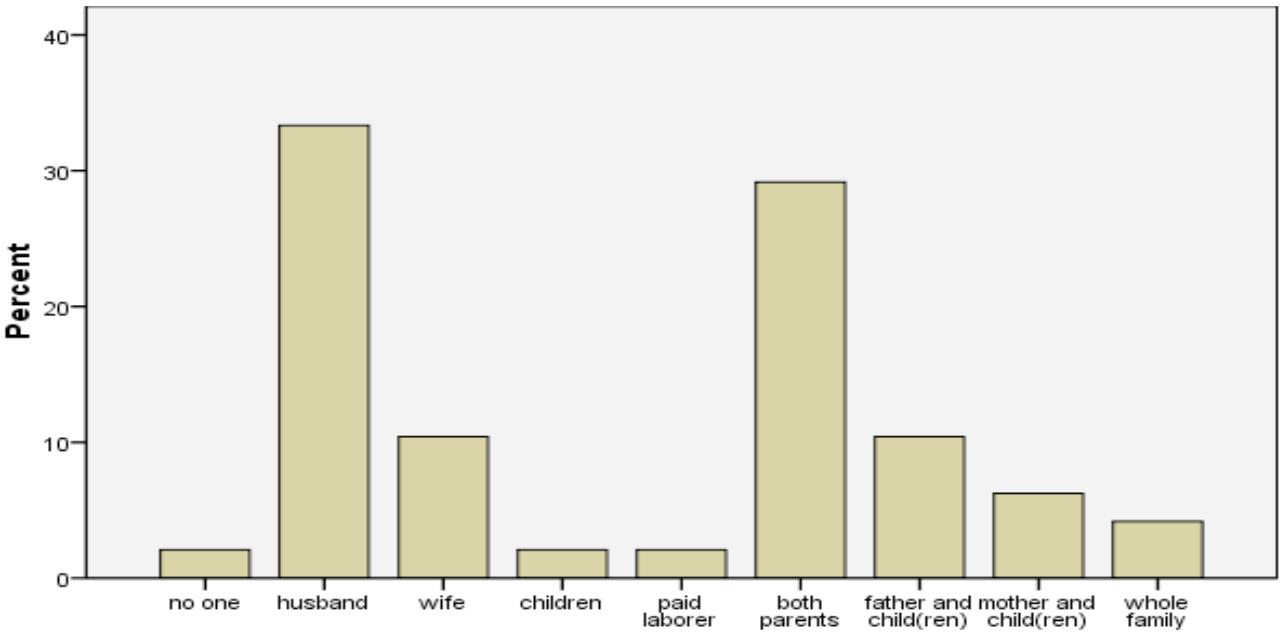

Figure 10: Person who gathers wood for each household in sample of Rosário da Limeira, Minas Gerais

Regarding the participants' understanding of the Atlantic Forest Policy, more people claimed to understand the meaning of the term *Reserva Legal* (Legal Reserve), than claimed to understand the meaning of the term *Área de Proteção Permanente* (Permanent Protection Area) (Table 8). More people claimed to have a LR on their property than claimed to have a PPA, although only 13% of respondents actually had a LR and/or PPA registered with the municipality. The majority of respondents (77%) were aware of some sort of restriction placed on use of AF resources, although many did not have an accurate understanding of what these restrictions were.

Table 8: Understanding of AF Policy by residents of Rosário da Limeira, Minas Gerais

	Understands LR	Understands PPA	Has LR	Has PPA	LR and/or PPA Registered	Aware of AF Restrictions
Yes	60%	24%	53%	25%	13%	77%
No	39%	76%	47%	75%	87%	23%

When asked how much the AF Policy influenced their use of forest resources on a scale of zero to five, with five indicating the highest level of influence, 27% of respondents claimed it had no influence, 29% of respondents claimed it had a medium degree of influence (3) and 17% of respondents claimed it had a high degree of influence (5). When asked how much the AF Policy influenced their fuelwood choices, 35% of respondents claimed it had no influence, 27% claimed it had a medium degree of influence (3) and 4% claimed it had a high degree of influence (5).

When asked about the importance of the forest (worded, *what is the importance of the forest?*) 10% or respondents replied that it is not important, 48% said it was important for maintaining the water supply, 23% said it was an important source of fuelwood and 12% said it was important for timber.

3.3 Hypothesis-testing Regression Analysis

In this section I describe the variables used to test the energy ladder model in this study region using a regression analysis. I then go into more detail regarding the regression and the results.

3.3.1 Variables used in hypothesis-testing regression analysis

In order to test the hypothesis that the socioeconomic status of a household explains fuelwood use, a dependent variable had to be chosen to represent the extent to which each household relied on wood as a source of energy. Measuring a household's dependency on fuelwood is notoriously challenging. The best measurement of a household's reliance on fuelwood would have been the actual amount of wood-generated energy consumed by each household on a monthly basis. However, it was not feasible to calculate this variable. Colloquial measurement systems are not standardized and methods for transporting fuelwood from the source to the home vary. Because of the varied fuelwood collecting systems and time-tables, ranging from one person picking up an armload of wood on the way home from work each day, to the whole family spending half-a-day three times a year gathering wood, most participants found it impossible to give me a value for fuel consumed each month in cubic meters. Additionally, most households surveyed did not rely exclusively on wood for cooking and heating water, but rather used it in combination with other fuel types, thereby lessening its importance and consequently the ability of participants to reliably estimate the amount of fuelwood used. Even if they had been able to do so, participants would also have needed to estimate the percentage of wood use made up by the individual species they collected because each species of tree may have a different energy density. Additionally, when converting cubic meters of wood in a woodpile to gigajoules of energy, even if it is all the same kind, there is a large error estimation due to the unknown percentage of the woodpile made up of empty space (Brannstrom, 2005). Due to these limitations, Time Spent Collecting Fuelwood was chosen as the closest approximation of a household's reliance on fuelwood that could be derived from this particular data set.

Due to these restrictions, two indirect measurements of a household's dependency on fuelwood were analyzed. The first represents the effort that a household devotes to fuelwood collection by calculating the average number of minutes each day that a household allocated for collecting wood for fuel. This variable was named Effort, measured in units of minutes per household per day. This variable was calculated indirectly using several other variables, including number of people collecting wood, fuelwood collection, frequency and time. The formula for the calculation is as follows:

=((∗ 60) /) /

Where E = Effort, t = time spent collecting fuelwood in hours, i = fuelwood collection interval, and p = number of people collecting.

This variable is not ideal as it does not perfectly represent the percentage of a household's domestic energy supplied by fuelwood; rather, it is an estimation of the time each household devoted to fuelwood gathering. The calculation of this variable cannot be entirely exact as it relies on several other variables, each of which is also estimation. Because nine of the 48 participants were not able to estimate all the variables needed for this calculation, it was not possible to calculate the value of the dependent variable for them and they were not used in the regression. This effectively reduced the already small sample size to an even smaller one for the purposes of the regression analysis.

The distribution of Effort is non-normal and has a broad range, from 0 minutes per day to more than 60 (Figure 11). The mean time that each house spent collecting fuelwood was 17.18 minute per day, with a standard deviation of 17.23. Due to the non-normal distribution of this variable, the values of each observation for this variable were converted to the log of the time estimated for the purpose of the regression analysis.

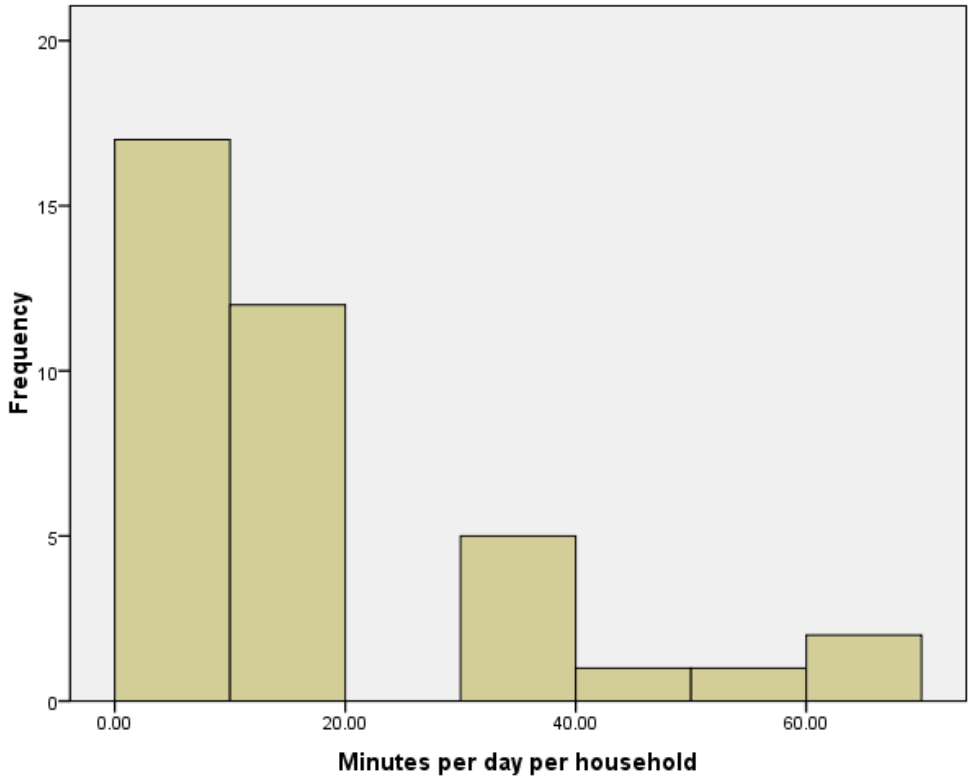

Figure 11: Time spent collecting fuelwood by households in sample of Rosário da Limeira, Minas Gerais

In addition to Effort, the number of purposes a household used fuelwood for was used as a dependent variable in the statistical analyses. This variable was called Fuelwood Use Category and has been discussed previously in this chapter (Figure 8).

The independent variable - socioeconomic status – was also defined indirectly. Seven indicator variables were selected to collectively represent the socioeconomic status of a household: home ownership, hectares of land owned, type of transportation, cell phone ownership, number of regular incomes, receipt of conditional cash transfers from the government (*Bolsa Familia*), and the level of education attained by both the

husband and wife.

The rate of land ownership, described in section 3.1.1 of this chapter, was chosen as another indicator of household status not because of the monetary value of the land itself, but the additional opportunities that come with owning the land. Most of the small landowners in this region did not acquire land through purchase; it would have been difficult for many of them to raise the required funds. Instead, they inherited the land from their parents. So, the possession of land is not necessarily correlated with affluence, but it does allow the household more freedom and opportunity for earning than households that do not own land. For example, one participant I interviewed is the caretaker on a very remote 19-hectare property composed mostly of pasture and native forest. This individual has not been in contact with the owners of the land in several years as the person who hired him as a caretaker passed away, and the offspring who inherited the property have shown no interest in it. Although the caretaker has access to all the natural resources of the property, he has no freedom to develop it in ways that could bring him more income. He cannot afford many cattle, and he is afraid to invest in eucalyptus or coffee plants because he is uncertain about the amount of time he will remain on the property given that the current owners may be inclined to sell it at any time. So, because he does not own the land, he cannot use it to his economic advantage. Meanwhile, a household owning a smaller property can earn income from less land because they have the confidence to invest in it. These observations justify the use of land ownership as an indicator of household status.

Mode of transportation was selected due to the expense of purchasing and running a motorized vehicle. Ownership of a motorized vehicle is relatively new in this region. The Director of Iracambi Atlantic Forest Research Center, who is also a local landowner, mentioned that 20 years ago when he first moved to the area he was one of the only rural residents that owned a car. Perhaps because of the increased economic opportunities available in the region brought about by mining activity and Rosário da Limeira's recent inauguration as the capital of the municipality, more people are now able to afford cars and they are no longer uncommon, even on the unpaved rural roads.

Thirty-three percent of households surveyed owned a car. Even so, not every household can afford to purchase and maintain a car. Among the households surveyed, two other important modes of transportation were observed: horse-carts and motorbikes.

Motorbikes also require an outlay of money to purchase and maintain but are much more affordable than cars. Because many households owned two or more of the three main modes of transportation, this variable was divided into the following five categories: car and motorbike, car, motorbike, horse-cart only, and none of the three modes of transportation. Because both cars and motorbikes are more expensive items than a horse-cart, households were assigned to a category based on ownership of these two more expensive vehicles (if a motorcycle and/or car were owned the household was placed in the corresponding category, regardless of whether or not they owned a horse-cart). Three households owned none of the surveyed vehicles and traveled by foot, horseback or bus. The majority of households surveyed owned some form of motorized transport (Table 9).

Table 9: Modes of transportation owned by households in sample of Rosário da Limeira, Minas Gerais

Mode of Transportation	Frequency	Percent	Cumulative Percent
Owns none of the surveyed means of transport	3	6.2	6.2
Owns horse-cart	19	39.6	45.8
Owns motorcycle	11	22.9	68.8
Owns car	8	16.7	85.4
Owns car and motorcycle	7	14.6	100.0

Cell phone ownership was also used as an indicator of affluence due to the high upfront cost of purchasing a cell phone and the usage fee through purchasing talking time. Eighteen of the surveyed households (38%) owned a cell phone.

The total number of regular monthly incomes received by a household was included as an indicator of status due to the increased purchasing options that a monthly supply of cash allows. Even a small amount of money, if received regularly and reliably would make it more feasible for a household to afford to regularly purchase items such as LPG, whereas if cash is obtained sporadically, purchasing canisters of gas becomes more difficult. For the purposes of this study, pensions were included as a regular income because several of the individuals surveyed were past working age but received monthly pensions. Of the households surveyed, seventeen (35%) had no regular incomes, although five of these received the *Bolsa Familia*. Sixteen (33%) had at least one and fifteen (31%) had two incomes (Table 10). In ten percent of households women worked outside the home (in all of the cases where women worked outside the home, their husbands did as well). After speaking to these women, I suspected that this factor could contribute to a decreased use of fuelwood because it was less likely that someone would be cooking at home during the day and after arriving home later in the day they would be more likely to use gas to quickly heat up some food, rather than take the time to prepare a meal over the wood stove. Additionally, it would make sense that the extra income would allow for more gas to be purchased. I thought that this might result in a lower average time spent collecting fuelwood by households with women working outside the home.A T-test was conducted to compare the average minutes-per-day-per-household spent collecting fuelwood by families where women worked outside the home, to time spent by households where women worked at home. This test showed no statistically significant difference in the average amount of time spent collected wood, although the mean for households with women working outside the home was higher - 18.3 minutes compared to 7.6 minutes for households women working at home.

Table 10: Total number of regular incomes per household in a sample from Rosário da Limeira, Minas Gerais

Number of Incomes	Frequency	Percent
0	17	35.4
1	16	33.3
2	15	31.2
Total	48	100

The receipt of *Bolsa Familia* payments was also included as an indicator of status because this program is designed for the poorest of Brazilian families. This conditional cash transfer program was developed in 2003 to integrate four previously existing cash transfer programs that each provided money for a specific purpose: to incentivize poor families to keep their children in school rather than send them to work; to provide funds for maternal nutrition; to provide money for purchasing basic food products; and to help with the purchase of LPG after federal subsidies for LPG were ended in 2001 (Hall, 2006). This program is targeted at households that earn less than R$50 a month and those that earn between R$50 and R$120 a month. Families falling into the first category earn a basic payment of R$50 a month regardless of the number of children they have. Families in the second category earn no basic payment. Both groups are eligible for payments of R$15 per child of school age, with a maximum benefit per household set at R$95. Thirty-one percent of households surveyed participated in some form of this program and therefore received a monthly payment of between R$50 and $95 from the government. In five of the surveyed households this was the only source of regular income.

Education was selected as an indicator of status because the Energy Ladder literature specifically mentions education as related to status and therefore to movement up or down the energy ladder (Israel, 2002). Among households surveyed, access to education has been irregular until very recently. Many of the participants I interviewed spoke of long, difficult walks to the nearest elementary school, and the impossibility of

attending high school in the city because of the lack of transportation. One of the women I interviewed was 27-years old at the time, which was my age as well. I commented on her having three children already over the age of seven, and she only half jokingly explained that after she finished elementary school there was nothing left to do but get married and have children; the high school was too far away to walk to and there was no bus service. In general, the older individuals interviewed had even less education, because even fewer schools were available at the time. Parents also used to take their children out of school once they were old enough to work all day in the coffee fields.

Among the households surveyed, 29% of husbands surveyed had no formal education, 62% had some elementary education, 4% had some high school education and 4% had graduated from high school. Fifteen percent of wives had no formal education, 77% of wives had some elementary education, 2% had some high school education and 6% had graduated from high school.

3.3.2 Regression analysis and results

Statistical analysis was used to test both the energy-ladder hypothesis and the available fuelwood as a moderator hypothesis using both Effort and Fuelwood Use Category as dependent variables. The seven indicators of socioeconomic status were combined into a single variable called "Status". This was done by calculating the z-values for each variable (by subtracting the mean for the variable from each value and dividing that figure by the standard deviation) and adding these z-values together to create one standardized variable (Figure 12). None of the variables used to represent Status are autocorrelated.

A linear regression was used to analyze the dependent variable Effort, and an ordinal logistic regression was used to analyze the dependent variable Class of Fuelwood Use, due to the data in the variable falling into discreet categories. All regressions were "jackknifed", which refers to the use of a "jackknife statistic", so-called because of its versatility. This is a "computer intensive internal replicability analysis", which is a form

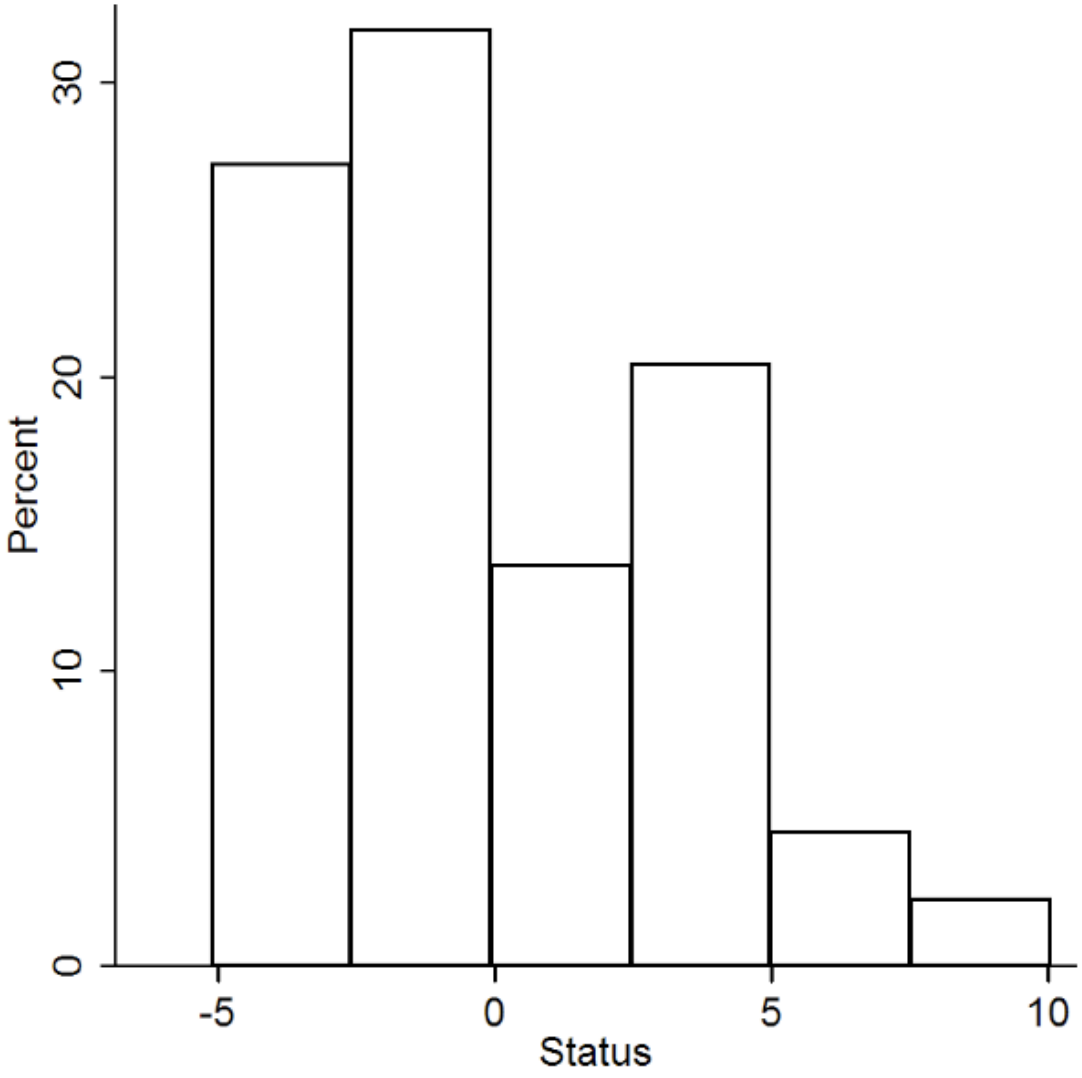

Figure 12: Frequency distribution of status scores for households sampled in Rosario da Limeira, MG.

of analysis that "attempts to mimic true replication without requiring a new sample" (Thompson, 2006). In the jackknife, replication is achieved by performing the regression analysis multiple times on the same data set; first with the entire data set, and then once more for each observation, each time omitting an observation, until each observation has been omitted from the regression once. In the case of this data set, the jackknife would have run 35 models (there are 34 households that have observations for both Time Spent Collecting Fuelwood and Status). By omitting each observation from the regression, this method calculates the impact of any outliers on the analysis. In the end, it adjusts the standard errors to reflect the influence of outliers on the model. The jackknife method is better suited to this particular data set than an Ordinary Least Squares regression, as the jackknife is especially appropriate for small sample sizes as well as dealing with outliers (Yoon, 1995, Thompson, 2006).

When the jackknife regression was performed with Status as the independent variable, the results were significant ($P = 0.032$) , with status explaining ten percent of the variance in Time Spent Collecting Fuelwood ($R^2 = 0.1074$) (Figure 13). Although this is a statistically significant proportion of the variance, it still leaves room for other factors, such as available fuelwood, to play an important role in the amount of effort a household puts into fuelwood collection.

The jackknife regression was then performed using Status, Available Fuelwood and the interaction between these two variables as the independent variables. Although neither Status nor Available Fuelwood were significant in this regression, the interaction term between them was ($P=0.010$) and the model as a whole explained 14% of the variance in Time Spent Collecting Fuelwood ($R^2 = 0.1921$). This result indicates that when the effect of outliers is taken into consideration, the relationship between Status and Time Spent Collecting Fuelwood depends on Available Fuelwood. Figure 14 demonstrates this relationship. For this figure, households were divided into two groups (Low, High) based on the amount of fuelwood available to them. This division was based on proportions of the population; roughly half of the population fell into each category. Each group has a different relationship between the predicted values for Time

Spent Collecting Fuelwood and Socioeconomic Status. For households with low (0 - 4.5 ha) access to fuelwood, Effort decreases as Status increases. However, for households with high (over 4.5 ha) access to fuelwood Effort effectively does not change, regardless of Status increases (Figure 14).

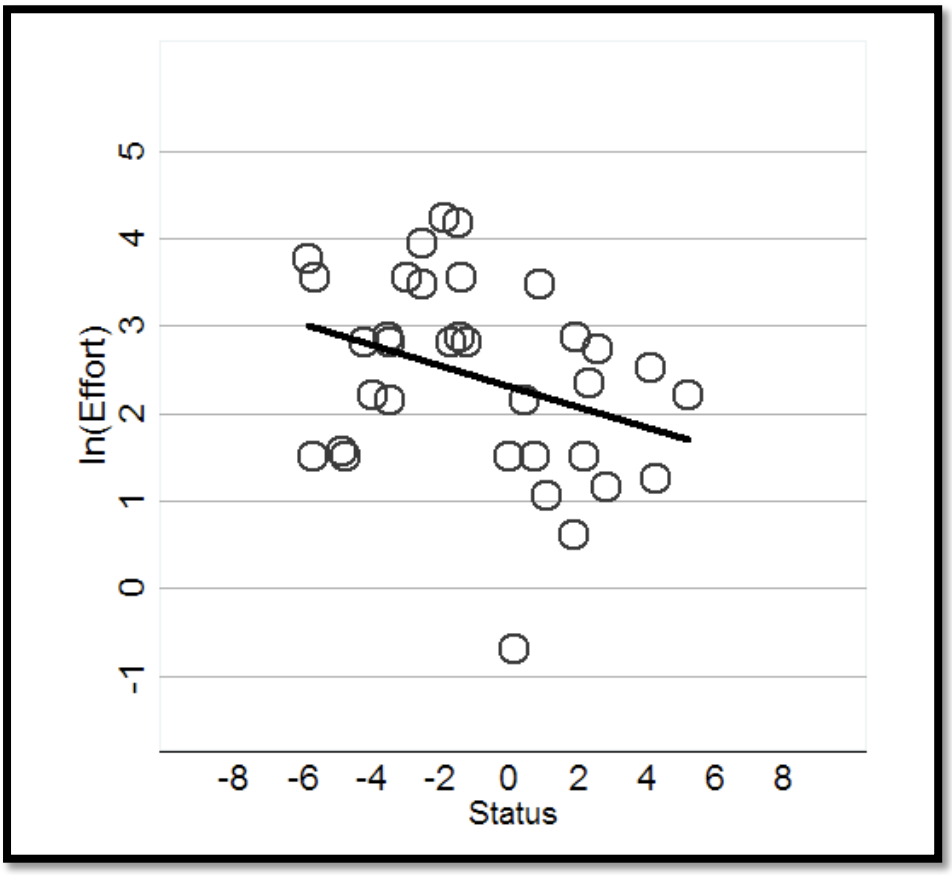

Figure 13: the relationship between the socioeconomic status of a household and the effort put into collecting fuelwood in in a sample from Rosário da Limeira, Minas Gerais

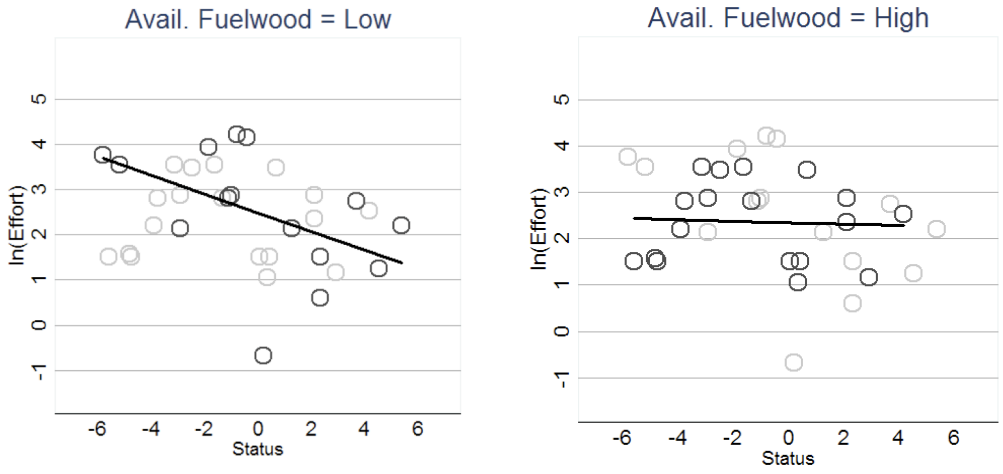

Figure 14: Moderating effect of access to fuelwood on relationship between socioeconomic status and time spent collecting fuelwood, in a sample from Rosário da Limeira, Minas Gerais

The results from the regressions using Class of Fuelwood Use as the dependent variable were not statistically significant. When status was tested as the only independent variable in this model the results were as follows: P = 0.30, R^2 = 0.01. When Access to Fuelwood and the interaction term were added, the model remained statistically insignificant, with P = 0.76 and R^2 = 0.02 . However the results from the regression using Effort as the dependent variable which showed that access to fuelwood was important in determining the relationship between socioeconomic status and fuelwood use, it was suspected that the same variable may have an important role in this interaction that was not showing up statistically due to the small sample size. Therefore, a cross tabulation analysis was done in order to descriptively assess the role of access to fuelwood in the relationship between socioeconomic status and class of fuelwood use. In order to do this analysis all three variables were condensed as follows. Observations of households who used no fuelwood were dropped because there were so few (2), and observations of households who used wood for three or more purposes were combined,

resulting in three fuelwood use categories, rather than 6. Status was divided into three groups, Low, Medium and High, based on the standard deviation from the mean, 1.96. And availability was divided into two groups, low and high. The results of this analysis can be seen graphically in the following three figures.

Figure 15 shows the percent of households in each status and fuelwood access group that use fuelwood for one purpose. The marginal group shows the trend that would be expected if access to fuelwood were not a factor. The low Availability and High Availability lines show the trend corresponding to each fuelwood group. The trend differs from the marginal trend to varying degrees, depending on the status of the household. For example, approximately 50% of high status households with low fuelwood availability use fuelwood for one purpose, while approximately 10% of households in the same status group with high access to fuelwood use fuelwood for one purpose. This would indicate that most high status households with higher fuelwood access may use fuelwood for more than one purpose, while nearly half the low status households with low access to fuelwood use fuelwood for only one purpose. However, a Komogorov-Smirnov test was done to determine whether these values are statistically different, and they are not.

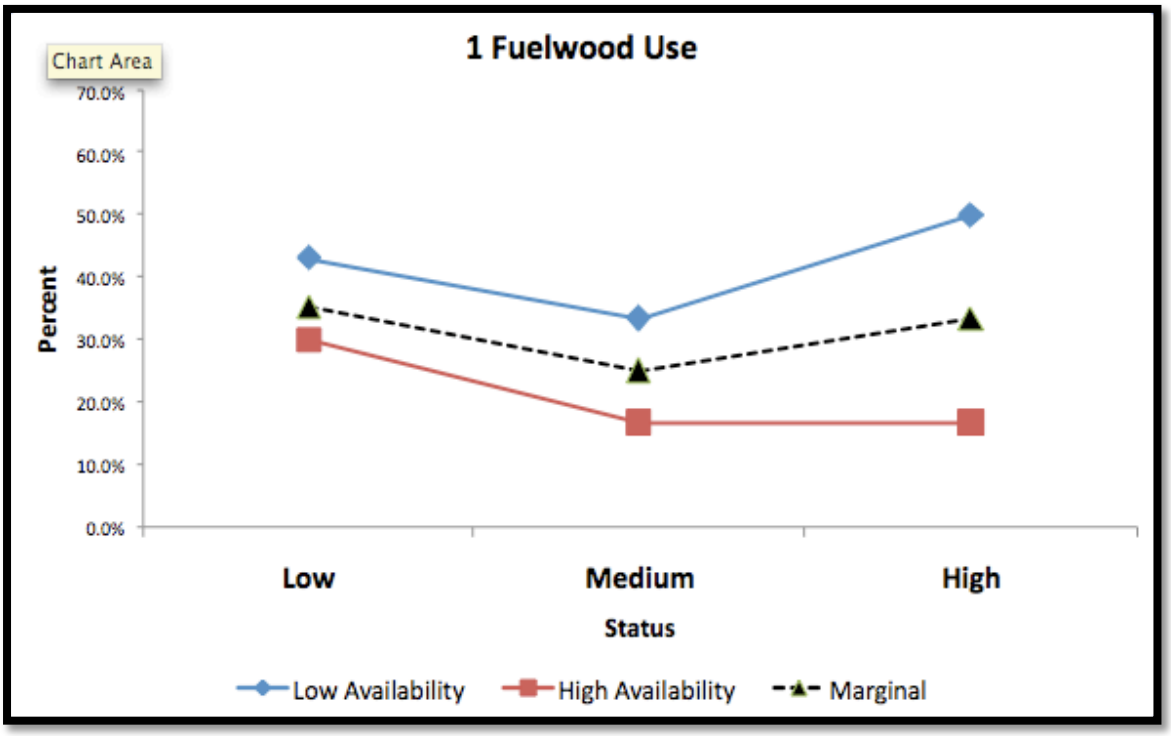

Figure 15: Percent of households in different status and fuelwood availability groups that use wood for one purpose

Figure 16 shows the percent of households in each status and fuelwood access group that use fuelwood for two purposes. The values for the low status group are nearly equal, however, the a higher percentage of low fuelwood availability households use fuelwood for two purposes in the middle status group than do households with high access to fuelwood. These positions switch for the high income group, for which a higher percentage of high availability households use fuelwood for two purposes than do low availability households. This could be explained by the assumption that as a the status of a low fuelwood availability household increases that household will choose to use wood for fewer purposes, while households with high access to fuelwood may continue to use fuelwood due to other factors such as tradition and personal preference. Again, these values were not determined to be statistically different.

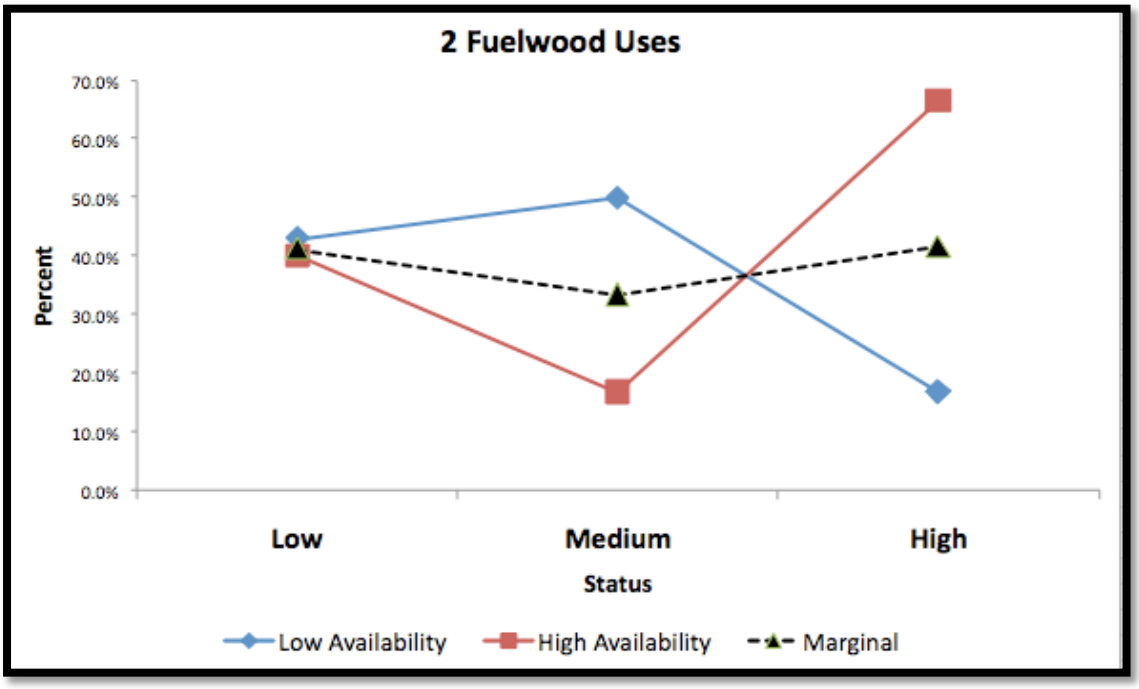

Figure 16: Percent of households in different status and fuelwood availability groups that use wood for two purposes

Figure 17 shows the percent of households in each status and fuelwood access group that use fuelwood for three or more purposes. The majority of medium status households with high fuelwood availability use fuelwood for three or more purposes, while fewer than 20% of the low availability groups in the same status do. However, these values were not determined to be statistically different. In the high status group, approximately 30% of low availability households and 10% of high availability households use wood for three or more purposes. It is difficult to explain why more households with less available fuelwood would use it more often than households with more availability, especially since these households are in the high status group and could afford to purchase LPG. However, these values are not statistically different and the anomaly could be due to the smallness of the sample size and the influence of outliers.

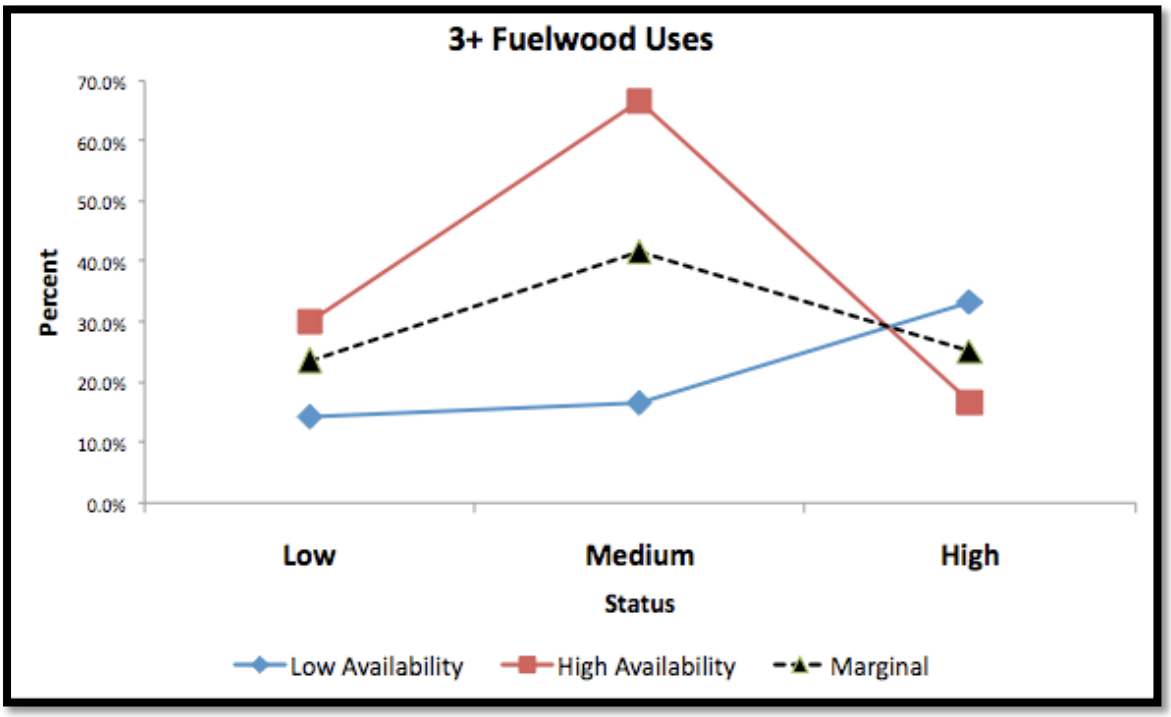

Figure 17: Percent of households in different status and fuelwood availability groups that use wood for three or more purposes

3.4 Discussion of Quantitative Results

The results of the regression analysis show that in this sample of rural residents of the *Zona da Mata Mineira* in Brazil, socioeconomic status, as it was calculated in this study, explains 10% of the variation in fuelwood collection time. This is a significant proportion of the variation, but still leaves much room for other factors to play influence the amount of time a household spends collecting fuelwood. This variable does not directly represent the dependency of a household on fuelwood so cannot be used to directly validate the energy ladder hypothesis. However, it is likely that the amount of effort a household puts into collecting fuelwood is proportionate the importance of wood as a source of energy for the household.

The other dependent variable tested, Class of Fuelwood Use, more directly represents a household's reliance on fuelwood, but analysis of this data set did not show a significant relationship between this variable and socioeconomic status. In other words, the energy ladder hypothesis is not supported by the data collected for this study, indicating that socioeconomic status on its own is not enough to explain energy decisions by rural households in the study region.

One potential explanation for this outcome is that the independent and dependent variables chosen in this study do not adequately represent socioeconomic status and reliance on fuelwood use, and that therefore the regression model in this study may not have reliably represented the energy ladder model. The reasons for selecting Time Spent Collecting Fuelwood as an indirect representation of a household's reliance on fuelwood have been discussed in a previous section of this chapter. Although the socioeconomic status variable used in the regression was not a direct measurement of socioeconomic status, I believe that the variables chosen to indirectly represent Status were the most appropriate given the circumstances of the study. Two of the variables included as status indicators were direct measurements of education (husband education and wife education) and others were the closest indirect measurements of income and wealth that could be obtained in this particular type of interview situation. Given this, I am confident

that the variables chosen for the regression model were sufficiently accurate to represent the energy ladder.

The more likely explanation for the low percentage of variance in fuelwood use that can be explained by a household's status is that in this region of Brazil fuelwood use is subjective and is driven by several factors, not only the socioeconomic status of a household. One of those factors is the amount of fuelwood that is available to a household. Although amount of fuelwood alone did not explain a significant percentage of the variance in time spent collecting fuelwood use, the interaction between socioeconomic status and available fuelwood explained 19% of this variance, which is statistically significant ($P = 0.010$).

Figure 14 shows that for households with low access to fuelwood (zero to four and a half hectares), time spent collecting fuelwood decreases steadily as socioeconomic status increases. This is in accordance with the energy ladder and can be explained by the observation that for households with little fuelwood, available LPG is the most convenient source of domestic energy and that poor households will use increasingly more LPG as their income permits. The trend for those households with high access to fuelwood (more than four and a half hectares) remained nearly the same for all households, regardless of socioeconomic status. It makes sense that households with high fuelwood availability would spend less time collecting fuelwood even if they rely heavily on it, due to the relative proximity of their fuelwood supply. It appears that households with more than 6 ha of fuelwood spent similar amounts of time collecting it, possibly indicating that fuelwood has similar importance for households with relatively plentiful fuelwood supplies across the status spectrum.

Despite the statistically significant affect that fuelwood availability has on the relationship between socioeconmic status and the effort a household puts into fuelwood collection, there was no statistically significant relationship between the interaction term and Class of Fuelwood Use, the other dependent variable chosen to indirectly represent a household's reliance on fuelwood. However, descriptive analysis of the affect that fuelwood availability has on the number of purposes a household uses wood for suggests

that access to fuelwood does play an important role in this relationship. There are several examples, presented in Figures 15 – 17, of instances in which households of similar socioeconomic status but in different fuelwood access groups differ in the number of uses they have for fuelwood. For example, nearly 70% of medium status, high fuelwood availability households use fuelwood for three or more purposes, while only about 15% of medium stats, low fuelwood availability use fuelwood this often. This makes sense based on the assumption that medium status households can afford LPG and may use it as a substitute for fuelwood more frequently if they do not have much access to fuelwood. Perhaps a larger sample size would have allowed for this interaction to be seen to a statistically significant extent.

3.5 Conclusions from Quantitative Data

It appears that the Energy Ladder model, relating a household's socioeconomic status to its reliance on fuelwood as a source of domestic energy, does not, on its own, explain the domestic energy decisions made by the surveyed members of rural communities of the *Zona da Mata Mineira*. Neither does the amount of fuelwood available to a household. However, the interaction between these two variables does explain a statistically significant percentage of the variance in time spent collecting fuelwood among the sample population. This indicates that the relationship between status and time spent collecting fuelwood is dependent, partially, on the amount of fuelwood available to a household.

Neither socioeconomic status nor fuelwood availability explain a significant percentage of the variance in Class of Fuelwood Use. However, a descriptive analysis of these variables suggests that fuelwood availability does play an important role, which may have been more significant in a larger sample size.

CHAPTER IV

BEYOND SOCIOECONOMIC STATUS: EXPLORING OTHER FACTORS AFFECTING FUELWOOD USE

The previous chapter of this thesis tested the hypothesis that the socioeconomic status of a household (based on income and education) in a rural region of the *Zona da Mata Mineira* in Brazil will explain the domestic fuelwood choices made by that household. This hypothesis was based on the Energy Ladder model described in the Introduction of this thesis. After statistically analyzing the data collected from a small sample of representative households in the municipality of Rosário da Limeira, variation in socioeconomic status among households explains only a small, albeit statistically significant, percentage of the variation in the amount of time a household dedicated to fuelwood collection (Effort), one of the dependent variables chosen to represent the importance of fuelwood to a household. Socioeconomic status had no significant interaction with the other dependent variable analyzed, the number of purposes a household used fuelwood for (Class of Fuelwood Use).

Several explanations for the weakness of socioeconomic status as a predictor of fuelwood use in this region may be outlined. One possibility is that the variables chosen to represent socioeconomic status were not the most appropriate. However, I do not consider this to be the case. Two of the variables included as status indicators were direct measurements of education (husband education and wife education) and others were the closest indirect measurements of income and wealth that could be obtained in this particular type of interview situation. Another potential flaw with the hypothesis tested is that Time Spent Collecting Fuelwood may not be the best indicator of a household's reliance on fuelwood. However, this was the best indicator of fuelwood reliance that could be measured under the particular circumstances of this study, and although it may not be an accurate measurement of the amount of fuelwood a household uses, it is reasonable to believe that the time a household dedicates to collecting

fuelwood should provide a general measure of a household's reliance on this type of fuel.

The more likely explanation for the low percentage of variance in fuelwood use explained by a household's status is that in this region of Brazil, fuelwood use is driven by a combination of factors, including socioeconomic status, none of which is strong enough to independently explain a significant percentage of the variation. This chapter argues that even when the socioeconomic status of households varies from relatively affluent to relatively poor, the average time spent collecting fuelwood can be quite similar due to differences in access to fuelwood, type of fuelwood available, environmental awareness and other factors. The following paragraphs illustrate this point by describing three households that differ in socioeconomic status but all spend similar amounts of time collecting fuelwood. Later sections of this chapter outline factors other than socioeconomic status that may contribute to variation in time spent collecting fuelwood.

The estimated time spent collecting fuelwood for these three households ranged between three and four minutes per day (Table 11). SP05 would be considered a wealthy household, located in the village closest to the capital of the municipality. The wife in SP05 is sister to the woman in SP07 (described in the previous chapter) and their husbands are brothers. Hence, this household is connected on both sides to the two most affluent families in the community. The circumstances of SP05 are very similar to that of SP07; they are relatively well educated and affluent. Both the husband and wife have completed high school and work in the city. They own their own land (12 ha), as well as a cell phone and a car, and they do not receive the *Bolsa Familia*. They have one teenage son who is completing high school. Their value for status, calculated using the z-scores of the variables chosen to represent status, was relatively high (4.05). Although this household does rely on gas as an important source of domestic energy (going through a 13kg canister every 45 days), they continue to use fuelwood to the extent that they spend an average of three minutes per day collecting it.

Time Spent Collecting Fuelwood for SP05 is not much lower than that of a household in different circumstances. GR11 consists of a young couple, employed by a large landowner to manage his eucalyptus plantation, and an infant child. They do not own their own land, but have been provided a house near the eucalyptus forest and have access to over 20 ha of wood. Neither the wife nor the husband has completed high school, but the husband is paid a regular salary and they own a cell phone and a motorbike. They do not receive the *Bolsa Familia*. Their status score was lower than SP05 (-2.17), but not among the lowest values. This household uses gas only infrequently, for activities like baking (one 13kg canister lasts them six months) and relies primarily on eucalyptus wood for cooking lunch and dinner. Because the husband works in the eucalyptus groves he has easy access to wood and this household does not spend much more time than SP05 on fuelwood collection (an average of four minutes per day).

Table 11: Values for Time Spent Collecting Fuelwood and status indicators for three households in in Rosário da Limeira, Minas Gerais

Participant	Time Spent Collecting Fuelwood	Uses 13 kg of gas every x months	Hectares owned	Ha of FW (access)	Category Transport	Cell Phone	≥ 1 regular income	Wife employed	Husband finished HS	Wife finished HS	Welfare	Status Score
SP05	3.0	1.5	12.0	1.0	4	X	X	X	X	X	-	4.05
GR11	4.0	6.0	0.0	20.0	3	X	-	-	-	-	-	-2.17
GR05	4.0	10.0	0.0	8.0	1	-	-	-	-	-	-	-6.33

Again, this value is the same as a household with a different set of circumstances that would be considered quite poor, with a status score of -6.33. GR05 is also a newlywed couple that does not own their land. Neither completed high school, and they

live on a rented property in a wood and mud house (most people who can afford it prefer to build their homes using brick). The husband works the coffee fields on the property and has a sharecropping agreement with the landowner whereby he receives 40 - 50% of the proceeds from the coffee sale. This household does not own a cell phone, car, motorbike or horse-cart. The wife of this household comes from a large and relatively poor family in the same village and sometimes works as a day laborer to bring in extra income. At the time of the interview this couple had no children and therefore would not be able to receive the *Bolsa Familia*, although if they did have school-age children they would probably qualify for it given their low income. This household relies on wood for cooking lunch and heating water for baths. They use gas for heating water for coffee, reheating dinner and for baking, but they estimated that one 13kg canister of gas lasts them ten months, indicating that they use it quite sparingly. Although their status score is very different from both SP07 and GR05, their estimated fuelwood collection time is very similar, four minutes per day. They use wood from coffee and from the forest, both of which are relatively plentiful on the land they inhabit.

As these three cases demonstrate, households with very different values for socioeconomic status may devote similar amounts of time to the collection of fuelwood. The question that this chapter will seek to answer is: What factors other than socioeconomic status account for the variation in fuelwood use in the *Zona da Mata Mineira*? In the remainder of this chapter I will seek to answer this question by addressing issues encountered during the interviews that were not included in the regression as they do not relate directly to socioeconomic status or access to fuelwood. I have selected several of the main issues that were identified from analysis of the qualitative data. All of the identified issues can be seen in Appendix D.

4.1 Type of Fuelwood

One factor that could potentially contribute to the variation in fuelwood use is the variety of fuelwood available to each household. As described in previous chapters,

there are essentially three categories of fuelwood used in this region: native woody vegetation, eucalyptus, and coffee. Some households have access to all three types; some have access to only one. Most households expressed no clear preference for a particular category of fuelwood, other than convenience. Approximately 60% of respondents used eucalyptus wood, either as the sole source of fuelwood or in combination with native species or coffee. Approximately 35% of respondents used native species, either as the sole source of fuelwood, or in combination with another type. Approximately 29% of respondents used coffee as fuelwood, the majority of these using it in combination with another type of wood. The frequency distribution for these responses can be seen in Table 6 of the previous chapter. Each of these categories of wood has its own set of corresponding issues, discussed in the paragraphs below.

4.1.1 Native species

One of the main factors determining whether a household uses native species for fuelwood is whether there is any native forest on the property that can be easily accessed. This in turn is determined by a long history of land-use choices that have been made by various actors over the past two centuries, continuing to the present.

The standard interpretation of the land-use history of the region is as follows. Non-indigenous exploitation of the forest resources began in the 19th century, when explorers began to scour the region for slaves, gold and timber. Colonization of the region progressed gradually, and increased in the 20th century when the metallurgy industry funded the clearing of large tracts of forest for charcoal. Family agriculturalists followed in the wake of this land clearance, setting up coffee plantations. As the years progressed, forest clearing continued with landholders clearing patches of forest on their property to sell for charcoal. In 1991, with the passing of law 99.547 prohibiting the destruction of Atlantic Forest, charcoal production from native forests became illegal in the *Zona da Mata Mineira*, yet it continued for nearly another decade until regulation by the forest police intensified, fines were increased and environmental awareness improved (Le Breton, 2008, personal interview; Dean, 1995).

Currently, the landscape in this region is a mosaic of landcover types, with native forest, mostly secondary growth, found mainly on hilltops (Figure 18). Primary forest is rare and found only in the most inaccessible locations in the region. The largest tracts of native forest are located in the most remote communities and members of communities near to the municipal capital have the least native forest on their property. Although many of the households surveyed did have some native forest on their property, in several cases the native fragments were far away or difficult to access. In these situations landowners may have planted eucalyptus trees closer to the house and make use of this wood rather than trekking to the forest.

Figure 18: Patchwork landscape typical of Rosário da Limeira, Minas Gerais

The description of landcover in the paragraph above is based on anecdotal observation rather than analysis of remotely sensed imagery. This type of analysis was attempted prior to conducting fieldwork, but it was found that the resolution of the available imagery (from CBERS (Chinese-Brazilian Earth Resources Satellite) and Google Earth) was not sufficiently high for accurate distinction between primary and secondary native forest; or native, eucalyptus and coffee trees.

Given this landcover context, does the amount and location of native forest on a property contribute to the variation in time spent collecting fuelwood? It is possible that if a landowner has not chosen to plant eucalyptus and does not have coffee trees ready to cull, the presence or absence of easily accessible native trees could contribute to the choice of domestic fuel for that household. Certainly if the only wood available on the property is far away or difficult to access, this could increase the amount of time a household spends collecting fuelwood and may lead a household to dedicate more funds towards the purchase of LPG, if this is an option. Alternatively, as native forest became increasingly inaccessible, landowners may have chosen to replace it with eucalyptus, locating the groves conveniently near the house. In short, qualitative observation suggests that the presence of native forest is one of the many factors contributing to the variation in fuelwood use in the region, but not a driving force.

Among respondents stating a preference for a specific fuelwood category (33% had no preference), more preferred native species (47%). Few households expressed a preference for cooking with a particular species of native wood. When asked about their favorite type of fuelwood, some respondents would simply say "*lenha do mato*" (fuelwood from the forest) or "*lenha nativa*" (native fuelwood), or "*qualquer uma*" (whichever one). Others would list the native species they most often used but generally did not express a favorite, indicating that no single native species is specifically sought after as a fuelwood. Most respondents who use native fuelwood seek out dead trees or limbs, as the dry wood is easier to transport and many people incorrectly believe that it is legal to cut down dead trees. However, 23% of respondents who use native fuelwood obtain it by cutting living trees. Even so, domestic fuelwood use in this region of Brazil

does not seem to place heavy pressure on the native forest fragments, although this subject could be studied in much greater detail to better understand the impact of this activity on the remaining Atlantic Forest fragments in the *Zona da Mata Mineira*.

The Atlantic Forest Policy is an important issue related to the use of native species as fuelwood that could possibly account for some of the variation in fuelwood use in the region. The history of this policy has been discussed in the Introduction of this thesis, but for the purposes of this discussion it is important to remind readers that this policy requires that all landowners set aside 20% of their property in native forest as a Legal Reserve, and that all environmentally sensitive areas on the property (primarily along rivers, around springs, hilltops and steep slopes) be covered by native vegetation as Permanent Protection Area. For properties smaller than 100 ha the PPAs can be included in the LR. Additionally, this policy prohibits the unlicensed felling of any native tree with a diameter greater than 10cm at chest height.

The principal requirements of the Atlantic Forest Policy seem straightforward in theory, yet in practice even these fundamental tenets are poorly understood by those whom they most directly affect - the family agriculturalists. Although the majority of interview respondents (77%) were aware of some sort of restriction on the use of Atlantic Forest resources, many respondents were unclear on the exact nature of these restrictions. The majority of respondents who were aware of restrictions believed that it was legal to fell dead trees. Another common misconception was that although it was illegal for households to remove trees from the forest for commercial purposes, the felling of trees to supply domestic needs (including energy and construction) was legal. Few respondents were aware that it is illegal to fell any native tree without a permit. One of the most educated survey participants on this topic seems to have learned the specificities of the policy through direct interaction with the law. She explained that ten years ago her husband deforested one of the remaining patches of forest on their property to make charcoal and was subsequently fined by forestry officials. This incident contributed to a more cautious approach to the use of forest resources by this particular household. As the woman explained, she would prefer to use native wood as

fuel and wishes that the law permitted it, but she now uses mainly eucalyptus wood because "IBAMA *fala que não pode tirar nem pau seco"* (IBAMA says we can't even take out fallen trees). Note that even this woman, who is relatively well educated on this particular topic, confuses the agency responsible for forest regulation in Minas Gerais, which is not IBAMA but the IEF.

Another aspect of the policy that is confusing to small landowners is the difference between the Legal Reserve and a Permanent Protection Area, both of which have been required since 1965. Of the households interviewed, 60% understood the term *Reserva Legal* (Legal Reserve), whereas only 24% understood the term *Área de Proteção Permanente* (Permanent Protection Area). Fifty-five percent of respondents said they had land set aside on their property as a reserve, although only 13% of respondents had a registered LR on their property; a requisite for selling the property, obtaining credit from state banks, and for obtaining a permit for the felling of a native tree. Twenty-six percent of respondents have some sort of PPA on their property, mostly around springs, since water scarcity has become a particular concern in recent years.

During my time in the field, I observed an attempt by the IEF to generate a better understanding of the basic tenets of the AF Policy among rural populations. It was simply a poster nailed to the door of a village church with cartoon-like depictions explaining the purposes of an LR and a PPA. Additionally, it explained that houses, livestock and agriculture must "respect" the LRs and PPAs and reminded landowners to register their LRs with the local officials.

Despite this and other attempts at AF Policy education by the IEF and other groups, understanding of and adherence to the AF Policy varied widely amongst research subjects. This is in part due to the reality of applying the AF Policy in a region like the *Zona da Mata Mineira*. Due to the topography of the region, it is very difficult for a small landowner to avoid utilizing hilltops, slopes and riparian zones for either agriculture or grazing. A statement by an employee of EMATER, a state-run organization that provides technical assistance and outreach for agricultural projects in

rural communities, exemplifies this situation: "The way the law currently is, it is impossible for small agriculturalists to abide by it. There are places where the entire property should be an PPA according to the law." This situation has been recognized by policy-makers and it appears that in the near future there may be modifications to the AF Policy that will allow sustainable uses of areas that are now PAAs. For example, in the state of São Paulo it is now permitted to plant fruit trees along the margins of rivers.

As the previous paragraphs describe, the AF Policy is poorly understood and in many cases difficult to abide by, factors that may help explain why households with native forest on their property may use those plots as a source of fuelwood. However, lack of regulation is another important factor in the continued felling of native trees, for fuelwood or other purposes. The organization responsible for regulating forest policy is the Forest Police, a branch of the Military Police made up of officers who have done an additional course relating to forest law. Their responsibility is to uphold this law, however, the reality of the situation is that the Forest Police have extremely limited resources. At the time of my interview the Forest Police unit for the 10 municipalities surrounding the city of Muriaé consisted of 6 officers (only three of which were working on any given day) and two vehicles. This situation is actually a great improvement on the state of the Forest Police little over a decade ago. Up until 1998 the Forest Police had no car, no radio and no telephone. Nevertheless, with so few officers covering such a large region, the ability of the Forest Police to monitor forest resources in detail is quite limited. Instead, they rely on *denúncias* (anonymous reports of illegal activity), generally relating to large-scale forest clearing and animal poaching.

Consequently, the regulation of small-scale cutting of native trees for domestic use is practically nonexistent. This reality means that many households may not have a legal incentive to stop their use of native wood for fuel or minor construction projects. The Forest Police have little inclination for this level of regulation. As one of the officers explained to me, if they do happen to discover someone using native wood for domestic purposes without a permit they will most likely "give the guy a break because he had to fix a fence or something and to fine someone for this is absurd."

This comment is an interesting contrast to others made by an employee of the IEF on the same topic. The role of the IEF is to propose and execute policies related to forestry, fisheries and sustainable agriculture in the state of Minas Gerais. This is the organization that a landowner must go to in order to obtain a permit to cut down a single native tree. I interviewed a young IEF technician who had recently graduated with a degree in Biology from the University of Belo Horizonte in the capital of Minas Gerais. He had only recently been assigned to work in Muriaé and it was obvious that he had very little experience with the reality of rural life in the region. His perception was that the majority of landowners in the region understand the basic tenets of the AF Policy, including the fact that even the felling of dead trees requires a permit. I asked him if he believed that a rural landowner would come to Muriaé to get a permit to cut down a dead tree if he needed it for fuelwood and he responded that yes, they would, because they could not legally cut the tree without such a permit. He did not seem to be aware of the difficulty that the average rural landowner might have in travelling to Muriaé: such a trip would probably cost more than the price of a 13kg canister of LPG and take at least half a day, requiring some form of transportation from the rural property to Rosário da Limeira, and from there an hour long bus trip. He also appeared to be unaware that many rural landowners would not be able to obtain a permit even if they were able to make the trip, as they do not have their Legal Reserves registered. Additionally, he seriously underestimated the amount of fuelwood required by a rural household. Some households I interviewed went through a tree a week for fuel and would never have been able to obtain a permit for such activity.

Not only was this technician remarkably disconnected from the reality of life for a population so directly influenced by the regulations his organization created, but he also held unrealistic expectations of the Forest Police, the organization responsible for enforcing these regulations. His belief was that a rural landowner would go to all the trouble of obtaining a permit to fell a single dead tree because if they did not they could receive an expensive fine from the Forest Police. He seemed entirely unaware of the impracticality of the Forest Police having the time or inclination to inspect woodpiles.

Of course, this was the impression of only one employee of the IEF, and it is possible that technicians with more experience in rural communities may have a more realistic concept of the practicalities of applying the details of the AF Policy. Nevertheless, it was interesting to note the disconnect between an employee of the organization responsible for promoting forest policy, an employee of the organization responsible for regulating that policy, and the rural people who are directly affected by the policy.

In summary, the AF Policy is not well understood by all rural wood-users, and even those who do understand it may find it difficult to abide by or may disregard it knowing that if they are discreet in their use of forest resources, it will go unnoticed and unpunished. The remarks of a municipal official in the study region, someone born and raised in a rural community, sums up this situation: "Many people cut trees without getting authorization. They know that they need to but they don't because it takes too long. And the Forest Police almost never come out here".

Therefore, I do not conclude that the Atlantic Forest Policy has a strong *direct* impact on the use of fuelwood in the study region. Rather, those households that have easy access to native trees will most likely make use of them as a source of fuel, unless they have had direct interaction with the law or have another motive for conserving native trees (such as preventing water shortage, a topic that will be discussed later in this chapter).

It should be noted that my position as an interviewer could have influenced the responses of households to questions regarding AF Policy and the use of native species. Most likely households overrepresented their understanding of AF Policy and underrepresented their use of native wood. If this is the case it would mean that the general understanding of AF Policy by rural inhabitants is even poorer than my data shows, and the extraction of native trees is even more pervasive, although not dramatically so. As I explained in the Methods chapter, although many respondents initially regarded the interviews with suspicion, in most of these cases I feel that participants became more relaxed as the interview proceeded and felt more comfortable

giving honest responses. Many households were candid about their use of native species and for most of the households that claimed to use eucalyptus this was the most obvious wood source on the property. I believe that the officials I interviewed were not strongly influenced by my position as a researcher and were candid in their responses regarding this topic.

4.1.2 Eucalyptus

The land-use history of the Rosário da Limeira has resulted in many households without easy access to native forest. Reforestation by native species is difficult in the poor soils and even if it were easy, most people would not choose this option as the land and trees on it would then become unavailable, according to the AF Policy. Instead, during the past 20 years, many landowners have chosen to plant eucalyptus trees. One of the main reasons for this choice is that certain species of eucalyptus are fast-growing and able to thrive in the soil depleted by decades of coffee plantations and pasture. Additionally, over the last two decades, landowners have been strongly encouraged to plant this tree. About 20 years ago the World Bank, in partnership with the IEF and a steel company, funded eucalyptus planting as an attempt to relieve pressure from the native forests. The steel company provided the seedlings for free and guaranteed purchase of the eucalyptus from producers. The IEF then produced seedlings, but people had to be able to transport them to their properties. This prevented many landowners in the study region from taking advantage of this opportunity. However, once Rosário da Limeira became a municipality in the late 1990s the local government was able to obtain its own vehicle for distribution of the saplings and provided this service to all interested landowners. As a result, more properties in this region began to plant eucalyptus.

Today, eucalyptus is an integral feature of the landscape and in certain places can be quite dominating. Not all of the surveyed households had eucalyptus on their property, but most of them did (see Table 8 in the previous chapter for a frequency distribution of eucalyptus grove sizes on surveyed properties). The incentives for planting this crop continue to make it an attractive option for land-use. Although the

steel company is no longer purchasing eucalyptus from the region, the local dairy industry is an important buyer, as well as the paper pulp industry. Additionally, although eucalyptus is treated by the IEF as a forest resource, rather than a crop, it is not so tightly regulated as the native forest, and therefore is a popular source of fuelwood and timber among rural households that have eucalyptus on their property.

Interestingly, the Director of Iracambi predicts that in the near future there will be technology for producing ethanol from cellulose, making eucalyptus an important source of biofuel in a country that already values ethanol as a fuel. In such an instance, the value of eucalyptus might increase to the point that it becomes too valuable for domestic use, in which case it may cease to be an important source of fuel for households. Currently however, many households in the study region do rely on eucalyptus as a replacement for native fuelwood and its accessibility (both physically and legally) may help explain the continued practice of domestic fuelwood use in areas where native forest is scarce.

The rate of eucalyptus use as a source of domestic fuel was higher than I anticipated from the information I gathered prior to the field research. One study conducted in the same region briefly focused on the inaccessibility of native species due to AF Policy and did not mention eucalyptus as a common source of fuelwood (Silveira, 2008). I was therefore surprised by the pervasiveness of eucalyptus groves and eucalyptus fuelwood and had not prepared survey or interview questions to focus on this phenomenon. Consequently, eucalyptus was discussed during the surveys and interviews, but not in great detail. A future study could go into more detail regarding the importance of eucalyptus as a replacement for domestic fuelwood as well as the ecological impacts of this monoculture.

4.1.3 Coffee

The third category of fuelwood used in this region is coffee. Coffee is integral to the regional landscape and present to some extent on most rural properties. However, it is only viable as a primary source of domestic fuel on properties with large coffee plantations that have a sufficient number of older bushes each year that need to be trimmed or culled. On such properties, there may be enough available coffee wood to fuel a small-scale coffee roaster or to sell to neighbors. Although both of these situations were encountered during the household surveys, they are not common in the region. Coffee is the least-used of the three types of fuelwood. When it is used, it is often in combination with other species. Therefore, the presence of coffee on a property is not a reliable indicator of available fuelwood on that property.

In summary, it is apparent from qualitative observations that land-use choices, and therefore the type and amount of fuelwood that can be easily accessed on the land inhabited by a particular household, vary from household to household. This variability in fuelwood type as well as the issues associated with each category is most likely a contributor to the variation in domestic fuelwood-use in the region. Although the AF Policy legally restricts the use of native species as fuelwood, it does not directly influence people's fuelwood choices. It is remarkable to note the disconnect between the AF Policy makers, the policy enforcers and the landowners directly affected by this policy.

4.2 Environmental Awareness

Another factor that could potentially explain some of the variation in fuelwood use in the study region is the awareness that each household has of environmental issues related to native forests. As discussed in the previous section, the understanding of

Atlantic Forest Policy by different interview participants varies across a continuum of knowledge from very little to quite proficient, with the majority of households having an incomplete understanding of the basic tenets. The same is true for awareness of other environmental issues, indirectly related to the AF Policy, such as water scarcity and mining, probably the two most important environmental concerns to households in the *Zona da Mata Mineira*. Although the availability of fuelwood was not seen as an environmental issue or concern by the majority of participants, knowledge of other related issues could contribute to the propensity of a household to choose to fell native trees for fuelwood.

Conscientisação, a term used to describe a consciousness of environmental issues and regulations, varies in the region and depends to some extent on the contact that each household has with government agencies and NGOs. For example, one of the communities in which surveys were conducted is on the edge of the Serra do Brigadeiro National Park. In the early 1990s the IEF began to createa buffer zone around the park, which included the area inhabited by this community. Initially, the IEF had planned to relocate all residents of this community in order to protect the buffer zone. However, community members, in conjunction with Iracambi, worked to convince the IEF that local residents would do a better job of protecting the buffer zone than the Forest Police. As part of this process, many members of the community became better educated on forest regulations and concerns. Additionally, Iracambi has had a strong presence in this particular community and many of its members have an enhanced environmental awareness due to this interaction. Slightly more participants in this community mentioned conservation of native forest and water as reasons for using eucalyptus compared to other communities, although respondents throughout the study region made similar comments. According to local officials as well as several survey participants, *conscientisação* in the region as a whole has increased over the past 15 years due to a combination of factors, including tougher regulation by the Forest Police, the location of the national park, environmental education in schools, the presence of Iracambi, and the increasing scarcity of water in the region.

Water scarcity is probably the most important environmental concern to residents of the study region. When asked about major household concerns, survey participants often mentioned water. The terms "Legal Reserve" and "Permanent Protection Areas" were often understood in the context of fencing-off and reforesting areas around springs, the resources for which are provided by the local government. When asked what important resources the forest provided to their household, 56% of respondents replied "water", while 18% of respondents answered "fuelwood and timber". Because residents of the region have been taught through government programs, NGOs and in school to associate the amount of water on a property with the number of trees around the springs, many survey participants expressed an appreciation for native trees and therefore a reluctance to cut them down, at least in areas surrounding springs. Several participants explained that they had switched from native fuelwood species to eucalyptus for this reason.

However, awareness of and concern for native trees in association with water did not always lead to a reduced reliance on native species of fuelwood. For example, the wife of household GR01 explained that she did not know whether or not there was a law restricting the use of native trees, but that she knew that it was important to conserve native forests because of the water supply. Even so, this household relied on native species for fuelwood, mostly from small living trees in the *capoeira* (secondary forest).

Not all households surveyed expressed a concern for the water supply. One of the most interesting comments on this subject was made by household GR07, from the community in the buffer zone of the national park, where many residents had a heightened awareness of environmental issues. This interview was especially interesting in that it was conducted with the whole family present, including the grandfather and grandmother, the father, mother and numerous children, all of whom participated in the interview. The family's understanding of environmental issues was quite strong, probably due in part to the interactions of other members of their community with the IEF and Iracambi. However, although they were aware of restrictions on the native forest, several family members expressed skepticism as to the necessity of these laws.

The father of the household, who remained sullen and quiet throughout most of the interview, spoke up vehemently when we came to the topic of restrictions on the forest. He explained that people say it is important to respect the forest because of water, but that this is an "*invenção*" (a made-up story) because he has seen springs with no forest around them that still produce water. He said that some trees, like eucalyptus, actually reduce the amount of water in springs. He also complained that the mining companies do not have to respect the restrictions, so it is not fair that the small agriculturalists are expected to. Not incoincidentally, 50% of this household's fuelwood comes from native species.

Awareness of environmental issues, specifically the connection between native forest and water supply, is another factor that varies from household to household, depending on the circumstances and environmental inclination of the members of each family. An awareness of this issue has made some households reluctant to fell native trees, which in some cases has driven an increase in the use of eucalyptus or LPG. However, in other households *conscientisação* is not strong or has not had a strong influence on domestic energy choices. It must be concluded that awareness of environmental issues is a variable that may make a minor contribution to domestic energy choices of some households, but that it is not a driving factor in the variation of fuelwood use in the region.

4.3 Women Working Outside the Home

The amount of time the female head of the household spends at home is another factor that may influence the extent to which a household uses fuelwood. As might be expected, in the communities surveyed, women are generally responsible for cooking and other domestic activities, while the men are responsible for working the land. However, in many households the wife may also help with agricultural activities on the property or as a day laborer, especially during the coffee harvesting season. This type of employment does not generally prevent a woman from preparing a wood-fired lunch

early in the morning before heading out to the field, if that is her normal method of cooking.

However, in 10% of households surveyed, women were regularly employed outside the home for the full working day. This type of work naturally limits the time women have for food preparation, as they leave the house in the morning and return in the evening. Statistical analysis did not show a significant difference in the average time spent collecting fuelwood by households where women worked at home, compared to those households in which women worked outside the home. However, a larger sample size of woman working outside the home may have shown a more significant difference in these two means given that more descriptive statistics as well as qualitative observation suggests that in these households women do tend to spend less time cooking with wood. For 80% of the households in the study in which women worked outside the home, a 13kg canister of gas lasted three months or less, indicating that these households use more LPG than the average household in the region. In 60% of these households fuelwood was used for one or fewer of the five purposes described in the last chapter. One working woman explained that she cooks with gas during the week for the sake of convenience, but during the weekend she cooks with wood. These figures and anecdotal information demonstrate the potential for households in which women work outside the home to use less fuelwood and more LPG, even if the woman would prefer to cook with wood.

4.4 Tradition and Fuel Preference

Finally, the extent to which a household is influenced by tradition may contribute to the variation in fuelwood use in the study region. "*Costume"*(tradition or custom) was the most cited reason for fuelwood use by study participants. Personal preference plays a role in determining the extent to which a household continues the tradition of cooking with wood. If a member of the household strongly prefers wood-fired food, or if a woman particularly enjoys cooking on a wood stove or finds it more convenient,

these factors may counter the incentives for switching to LPG and make the time spent collecting fuelwood worthwhile. On the other hand, if a woman finds cooking with LPG more convenient and neither she nor her family members prefer the taste of wood-fired food, the household may opt to use more LPG. One of the most common uses for the LPG ovens, found in nearly every household, was heating coffee and baking cakes, both of which are foods that do not benefit from a wood-cooked flavor and are more conveniently done on a gas stove. On the other hand, some households that cooked mostly with LPG continued to use wood stoves to cook certain foods like beans, which take a long time and are said to taste better when cooked over wood. These general descriptions exemplify how personal preference for the flavor of certain wood-cooked foods may influence the choices that a household makes regarding domestic fuel. Although personal preference may not always override the socioeconomic circumstances of a household, if a family is in a position of having options regarding domestic fuel, personal preference and tradition may influence the type(s) of fuel they choose, leading to a variation in fuelwood use that cannot solely be accounted for by objective factors such as socioeconomic status. This issue could be examined in more detail by asking participants about preferred fuel types for specific foods under ideal circumstances.

4.5 Conclusions from Qualitative Data

This chapter has demonstrated the possible ways in which fuelwood use in the *Zona da Mata Mineira* may be determined by factors not directly related to socioeconomic status or access to fuelwood. None of the factors discussed in this chapter can be considered the principal variable responsible for the variation in fuelwood use seen in this region, however, they may account for some of the variation in this activity that was not accounted for by socioeconomic status, access to fuelwood and the interaction between these two variables. The factors discussed in this chapter may help to explain the relatively poor explanatory power of the energy ladder hypothesis. Additionally, these factors help explain the relatively low, albeit statistically significant,

percentage of the variance in time spent collecting fuelwood that could be predicted by the interaction between socioeconomic status and access to fuelwood.

CHAPTER V

PRINCIPAL FINDINGS AND LIMITATIONS OF THE STUDY

In this chapter I will discuss the main findings of my research and their implications, the possible future of fuelwood use in this region of Brazil, the limitations of my study, and the potential for future research that builds on my findings.

5.1 Principal Findings

5.1.1 Poor predictive power of the energy ladder hypothesis

The most interesting finding resulting from this study is that the Energy Ladder hypothesis is only weakly supported by the household survey data collected in the study region. In other words, socioeconomic status alone is not sufficient to explain the variation in fuelwood use in the study region. This is not to say that socioeconomic status has no impact on a household's domestic energy choices, but that it is not the strongest driver, and certainly not the only factor influencing such decisions. The type of fuel a household uses is influenced to different degrees by several factors, including income and education but also access to fuelwood, tradition, and personal preference. Observations of circumstances at the study site suggested that access to fuelwood might be one of the more important factors influencing household energy decisions. In fact, statistical analysis showed that the interaction between the socioeconomic status of a household and that household's access to fuelwood explains a significant percentage of the variation in fuelwood use in the study region, more so than either socioeconomic status or access to fuelwood on their own. In summary, analysis of the quantitative data suggests that access to fuelwood supplies moderates the effect of socioeconomic status on household fuelwood consumption.

If access to fuelwood is important, what factors determine access to fuelwood supplies? In this part of Brazil, land-use patterns and land-labor relations influence

access to wood as well as other natural resources. Luso-Brazilian settlement in the Zona da Mata Mineira began with explorers in the 19th century, who exploited the region for products of value. Gradually, Luso-Brazilians began to settle in the region, most heavily during the 20th century when the metallurgy industry motivated the clearing of large tracts of forest for charcoal. Once land was cleared it was quickly settled by family agriculturalists that established coffee plantations. Over time, forest clearing continued, with landholders clearing patches of forest on their property to sell for charcoal, plant coffee and graze cattle. Gradually, a mosaic of landcover types was created, ranging from primary native forest to *capoeira* (secondary growth of native forest) to coffee, pasture and eucalyptus.

Contemporaneous to these processes, the average size of property decreased over the generations as fathers divided up their land between their sons. These two processes - land use and land inheritance - have resulted in the current situation whereby most land owners have relatively small parcels of land over which patches of native forest, *capoeira*, coffee, pasture and eucalyptus are unevenly distributed. Most landowning households have access to some type of fuelwood in native forest, coffee or eucalyptus; however a few inhabit land with no wood reserves due to past land-use choices.

The other important factor that influences fuelwood access for families that do not own their own property is land-labor relations. Historically, there were three types of land-labor regimes employed in the mid-20th century on what was at that time the Brazilian agricultural frontier: contractual planting, sharecropping and wage laboring (Brannstrom, 2000). Each of these models was comprised of a particular set of rules, while sharing the common traits of reducing the risk and transaction costs of coffee farming for landowners, while exploiting information asymmetries between the landowner and the laboring family. While I observed no examples of the contractual planting model at the study site, all of the non-landowning households I surveyed could be placed into either the sharecropping or wage laborer category. The majority of these households received a salary in exchange for managing the property of the landowner. Their work obligations often involved harvesting coffee, managing any forest, native or

eucalyptus, as well as caring for livestock and protecting the grounds from intruders. The source of capital for the materials needed to maintain the property in these cases is unknown; similarly, it is not known whether the families received a portion of the proceeds from the sales of any of the resources they had harvested for the landowner (coffee, eucalyptus, milk, beef, etc). Generally, the more input a worker supplies, the more harvest he is allowed to keep. In addition to the salary, the employed family often received the right to occupy a house, sometimes with electricity paid for, as well as access to many of the natural resources on the property, such as water and wood. The amount and type of wood available for the employee to use was highly dependent on the past and current landowner's land-use decisions. For example, one property, owned by a man who had preserved a large percentage of the land in native forest, was home to caretakers who used mostly native species for fuelwood and had no concerns about fuelwood supply. On another large ranch in the same community the landowner had converted almost the entire property to pasture, and the caretakers purchased almost all of their fuelwood. On a nearby piece of land, the owner had invested in planting eucalyptus to the extent that there was no native forest, but a plentiful supply of eucalyptus wood that the caretakers used for fuel. In another village I interviewed a family employed by a landowner to care for his cattle. The property was composed entirely of pasture and the family had no access to fuelwood and used only LPG. As these examples demonstrate, access to fuelwood is generally not a factor that can be controlled by wage laborers, regardless of their socioeconomic status, which is not equal in every case as some caretakers earn more and/or are better educated than others.

Two non-landowning households I surveyed were not employed as caretakers but had gained access to land through sharecropping relationships. Sharecroppers received no salary but in exchange for a portion of farm or ranch output (between 40 and 50%), they were responsible for purchasing materials needed to maintain the property and its products. Although these households differ from wage laboring households in the regularity and amount of their income, their fuelwood access is determined in the same way, by the past and present land-use choices of the landowner. Of the three

sharecropping households interviewed, two had access to native forest (at least 21 ha) from which they sourced their fuelwood. The other had no wood other than coffee on the property and therefore regularly purchased LPG even though it was not the preferred energy choice of that household. Although sharecroppers may, in theory, have more control over land-use decisions, they will have a strong incentive to use as much of the property for coffee as capital and labor permit. This creates a potential disincentive for maintaining a reliable fuelwood supply on these types of properties.

Together, the combination of historic and current land-use choices, as well as land-labor regimes inherited from the early 20th century, create a complicated situation in which many households cannot control access to fuelwood. Until recent years the supply of fuelwood was not a concern as most properties had some type of fuelwood reserve on them. However, as the size of landholdings as well as forest fragments has decreased over time, fuelwood scarcity has become an issue that increasing numbers of households in the study region must face. For some, the loss of fuelwood poses little problem because they can afford to switch to LPG. But for low-income households this switch is more problematic, although many are forced to make it.

5.1.2 Ineffectuality of the Atlantic Forest Policy in preventing harvesting of native species for fuelwood

Another interesting finding from my research was that the Atlantic Forest Policyis not among the most important factors that influence fuelwood use in the region.I had anticipated that the AF Policy would place some sort of restriction on the access of households in the region to fuelwood because it prohibits the felling of any native tree, living or non-living. However, this regulation had surprisingly little influence on the domestic energy decisions of the households surveyed. This appears to be due in part to the increasing supply of eucalyptus, which is replacing native forests as the principal source of both industrial and domestic fuelwood. Nevertheless, many of the surveyed households continued to rely on native species for fuelwood. In most of these cases the understanding of the restrictions placed on the use of native trees was very poor. Many households believe that it is legal to fell living native trees for domestic use, and nearly all the households surveyed believed that it was legal to fell dead native trees.

Although I found no evidence that the policy actually encouraged deforestation, as did Hodge (1992), I did not focus on this question, and it may have been that owners of the more heavily deforested properties had considered the restrictions of the AF Policy when making the decision to remove forest from their property.

Why is such a well-established and important policy so ineffective in controlling the small-scale use of native tree species? This is best explained by a combination of factors, including the disconnect between policy-makers and natural resource users, the inadequate resources of the forest police, the difficulty in monitoring the felling of individuals trees over a large area, and the unwillingness of the forest police to punish households.

This situation raises several questions regarding the best strategies for protecting a fragile ecosystem while at the same time allowing for people to proceed with their livelihoods within that ecosystem. If policy makers were aware of the extent to which rural households in the study region rely on fuelwood, would they be willing to modify the law so that people could legally harvest native species for domestic use? What type of impact does the existing harvest of native species for fuelwood have on AF fragments? Is it better, in terms of AF conservation, to obtain wood from eucalyptus monocultures than from AF fragments? What would be the implications of legalizing the harvest of native species for domestic use? Given that most households are not aware that it is illegal to harvest native species, it may not have much of an impact on the forest to legalize this use. Are there ways of making the Atlantic Forest Policy more useful so that it continues to protect the forest but also allows for people to have a reliable supply of fuelwood? New versions of the policy that have been accepted by other states, such as São Paulo, allow for the cultivation of tree crops within Atlantic Forest fragments for a given number of years. Perhaps the law could be modified to encourage households to plant fast-growing native species as a source of fuelwood. This could potentially have a dual benefit of encouraging reforestation with native species rather than eucalyptus and providing households with a reliable source of fuel.

Finally, it is surprising that there is not more research done on the effectiveness of the AF Policy considering the strength of the law, its status in the environmental movement, and the potential impact on the environment.

5.2 The Future of Fuelwood Use in the Zona da Mata Mineira

A related issue is that of the future of fuelwood use in the *Zona da Mata Mineira*. Some might argue that policies should not encourage the use of fuelwood as the transition to more advanced sources of fuel such as LPG is underway and may soon be complete. However, given that fuelwood use continues to be prevalent in the study region, it seems prudent to question the assumption that the move away from fuelwood is inevitable and would be beneficial to the region. In recent years, developed countries have begun to look to wood again as a relatively clean and efficient source of renewable energy and it is possible that Brazil would find benefit in the promotion of wood as a source of domestic energy, particularly in rural areas where its use is still common.

In Europe, the use of wood as a source of energy, through advanced wood combustion (AWC, defined as an automated, highly efficient wood-fired energy system with strict air pollution controls) has gained in popularity in regions like Scandinavia, central and Eastern Europe, France, Germany and Austria (deB. Richter Jr. *et a*l, 2009). In these regions, AWCs are generally local, community-based and serve as a source of heating, cooling and electricity for towns, portions of cities, industrial complexes and public institutions. In this situation, the benefits of wood as a source of fuel include a reduction in greenhouse gas emissions, a reduced reliance on imported fuel and a renewable source of energy.

These benefits have been touted by the Forestry Commission of England in a recent campaign to promote "Woodfuel: energy that grows on trees". In a leaflet distributed by the Commission this past summer at a county fair I visited in southern England, wood is described as an efficient, clean and renewable source of fuel (Ireland

et al, 2006). The leaflet explains that the management of forests for fuelwood can be sustainable and beneficial to biodiversity and that a fuelwood market could create rural jobs.

In a recent article published in the Policy Forum section of *Science*, a case is made for the implementation of community-based AWC in the United States. A number of states including Idaho, Montana, Nevada, North Dakota and Utah already promote renewable AWC through the USDA Forest Service's "Fuel for Schools" program. Vermont is currently the leader in this program with about 30 public schools heated with biomass. Additional wood-energy projects funded by the Forest Service and American Recovery and Reinvestment Act are listed in a recently published document entitled "Wood to Energy and Biomass" (Forest Service and ARRA, 2009). These projects range from providing fuelwood to a cement plant in Arizona; to installing a woody-biomass boiler at a prison in Colorado; to converting public buildings in Maine to wood/dual fuel heating.

Despite the many benefits of wood as a source of fuel, in countries where most households have not used fuelwood for generations, wood is often perceived as an old-fashioned, inefficient, dirty source of energy that is bad for forests. Overcoming this perception is one of the biggest obstacles facing the implementation of AWCs in countries like the US and the UK (deB. Richter Jr. *et al*, 2009). Although modern technologies and forest management have changed the impacts of wood burning in developed countries, it may still take years for AWCs to gain broad social acceptance in developed nations. In rural Brazil however, communities may be more open to the use of wood, not only for cooking and heating water in individual households, but also as a potential source of electricity for towns and portions of cities as it is being used in AWCs in Europe.

If Brazil as a nation, or states in forested regions of Brazil like Minas Gerais, were to actively promote wood as a source of energy, a reliable source of wood would be necessary. Although the harvesting of individual native trees from Atlantic Forest fragments may arguably have a negligible impact on the ecosystem, the large-scale

felling of native trees in this region would not be sustainable. Currently, the best source of fuelwood both for households, industry and potential AWCs are the eucalyptus plantations that are already common in the region. The benefits of eucalyptus as a source of fuel are that is legal to use, fast-growing, easily accessible and can be planted in poor soils. The disadvantages are that it is an exotic monoculture that depletes the soil of any remaining nutrients.

An additional potential problem with relying on eucalyptus as a source of domestic fuel was suggested by the Director of Iracambi Atlantic Forest Research Center in a personal interview I conducted with him during the study. He predicts that in the near future, the technology for producing ethanol from wood will be developed and eucalyptus will then become an important source of biofuel in a country that is already a leading producer and user of ethanol. If such a situation did occur, eucalyptus could become too valuable for households to burn at home and an alternative source of fuelwood would be needed. He suggested some fast growing woody plants that could be planted for fuelwood should the need arise. One of his suggestions was a plant known as pigeon pea (*Cajanus cajan*), a native to the Caribbean that has been cultivated in several countries for nutritional and medicinal purposes. As well as being fast-growing and having woody stems that could be used for fuel, pigeon pea produces a nutritious bean, fixes nitrogen, has leaves that cattle like to eat and sprouts when re-cut. As such it seems like a promising option for domestic use if other sources of fuelwood were to become unviable in the region. A native species known locally as Pau-Jacaré (*Piptadenis gonoacantha*), which is a fast growing tree and able to grow in poor soils was also suggested.

5.3 Limitations of the Study

This study was limited by several factors. Due to time constraint, a true pilot study was not conducted. Such a study may have helped identify the importance of eucalyptus and access to fuelwood earlier, which could have led to a more thorough investigation of these issues. Additionally, due to time and labor constraints, the number

of household interviews conducted was small compared to what is generally required for rigorous statistical analysis. This led to a limited choice of statistical tools that could be used in the analysis without being heavily influenced by the outliers in the sample.

A further limitation to the study was my association as a researcher with Iracambi Atlantic Forest Research and Conservation Center. Although this study would have been much more difficult to conduct without the help of this NGO, when a researcher is associated with a known organization in the study region, participants in the study may have a preconceived notion, either positive or negative, of the researcher and the study being conducted. Iracambi is very active in the local area and most residents have formed some kind perception of the work that this NGO does. Often it is a positive one, but equally often it is negative. Additionally, because of all the previous research that Iracambi has sponsored in the local area, some of the communities suffer from research exhaustion, meaning that they are tired of being pestered for interviews from which they see no immediate benefit.

The sensitive nature of fuelwood use in this region due to the legal issues surrounding wood collection from the native forests was also a limitation to this study.

Another challenge faced by this study was that both the dependent variable, and what turned out to be one of the key independent variables - access to fuelwood – are complicated factors to measure directly in the context of rural Brazil. The difficulties in gaining precise data regarding how much energy from fuelwood a household uses has been discussed in previous chapters. Due to time and other constraints I had to estimate this information using a proxy variable (time spent collecting fuelwood). Even if I had had more time and the proper visa for research involving biological samples, this variable would have been difficult to measure due to the participant's suspicions. They were anxious enough when I was merely asking questions and I know that they would have been even more suspicious if I had actually been measuring their woodpiles. However, in a future study it may be possible to gain the trust of a few participants and take the time to thoroughly measure the amount of fuelwood they use and take note of the species composition of their woodpiles.

As discussed earlier in this chapter, access to fuelwood, one of the key independent variables explaining reliance on fuelwood, is based on complicated land-use patterns and land-labor relationships that are equally difficult to gain a thorough understanding of, especially as the importance of access to fuelwood in moderating the effect of socioeconomic status on fuelwood use was not realized until the data collected from the study had been analyzed.

5.4 Potential for Further Research

Future studies on fuelwood use in the *Zona da Mata Mineira,* or other similar rural areas, would benefit from dividing communities into different populations based on access to fuelwood and investigating the driving forces behind fuelwood use within each population (Figure 10). This would require sampling more households within each population than I was able to sample. Additionally, a future researcher would benefit from collaborating with a local laboratory so that she would have the resources to be able to measure the amount and types of fuelwood being used in a more accurate manner. In order to better understand the land-labor relationships involved in this topic, the researcher could choose a few households within each population to spend more time with in an effort to gain the participants confidence as well as a better understanding of their situation regarding access to fuelwood.

Another topic for future research would focus more on eucalyptus and people's motivation for planting it, the resources available for planting, the regulations behind harvesting eucalyptus, the industrial market for eucalyptus, and the impact that eucalyptus has on the local environment.

Another issue that was not rigorously studied in this project was the real ecological impact that the harvesting of native species for fuelwood has on the AF fragments in the region. It would be interesting to closely monitor the cutting of native species for this purpose and gain a real understanding of how the ecosystem is affected by this activity.

A final suggestion for future research regarding fuelwood in this region is to gain a better understanding of residents' desire to continue to use fuelwood if a legal, sustainable source were available. The researcher could also to determine whether the local governments would support some kind of advanced wood combustion system to generate local power. The potential options for sustainable fuelwood sources could also be investigated more thoroughly.

CHAPTER V

CONCLUSION

Fuelwood plays an important role as a source of domestic energy for rural residents of the *Zona da Mata Mineira* in Brazil. Socioeconomic status, the most common predictor for reliance on fuelwood based on the Energy Ladder model, does not in itself explain much of the variance in fuelwood use in this region. Access to fuelwood, which in some rural environments has been shown to have a greater influence on domestic fuel choices than socioeconomic status, was also not a strong predictor of fuelwood use in this particular region. However, the interaction between these two variables was shown to explain a statistically significant percentage of the variance in fuelwood use ($P = 0.010$, $R^2 = 0.1921$).

The most commonly used type of fuelwood among survey participants was eucalyptus, which is exotic to the region. Many households also continue to rely on native species for fuel, despite the illegality of felling trees, living or non-living, from the Atlantic Forest without a permit. The Atlantic Forest Policy seems to have little influence on domestic fuelwood choices. Few interviewees had a good understanding of the basic tenets of this policy and the Forest Police have inadequate resources to monitor tree felling at this level. A remarkable disconnect exists between Atlantic Forest Policy makers, policy enforcers, and resource users regarding the resource needs of small-scale agriculturalists, the exact restrictions the law places on forest resources and the willingness of law enforcement to monitor small infringements on these restrictions.

The continued use of wood as a source of domestic energy in this region should not be discounted, despite the increased use of LPG and the recent electrification of the region. Fuelwood use is still pervasive and given current *interest in* clean and renewable energy, wood could, with the use of modern technology and a sustainable source, provide an attractive source of energy for individual households if *not* entire communities.

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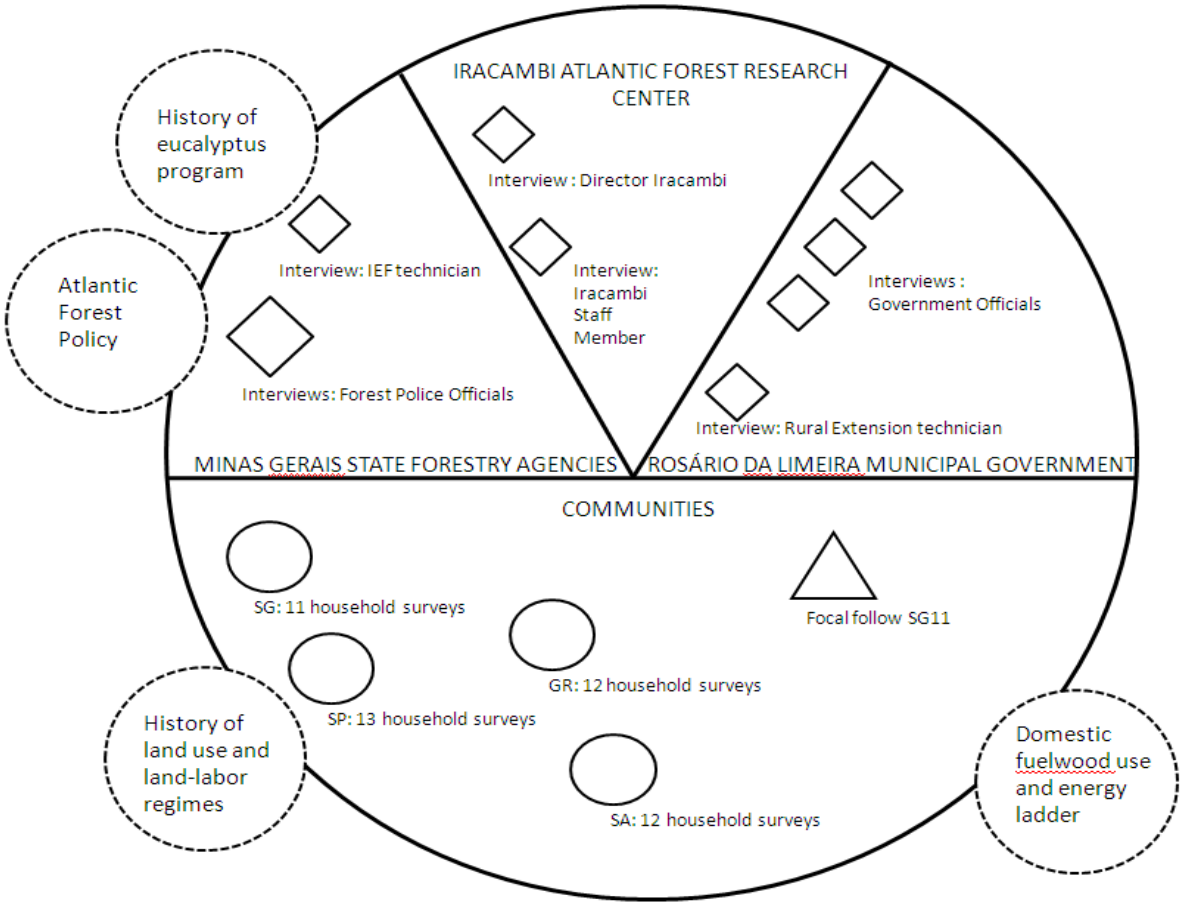
APPENDIX A

PLAN FOR ROSÁRIO DA LIMEIRA CASE STUDY INTO FUELWOOD USE



APPENDIX B

HOUSEHOLD SURVEY IN ENGLISH

Fuel use in three villages in the Zona da Mata Mineira, Brazil

Household Socio-Economic Survey Instrument (rev. 30 Oct. 09)

Location: _____ (Community)

Survey #:

Date: Interviewer:

Data Entry:
Who:
Date:
Validation:
Who:
Date:

1: Main Household Dwelling

Is the house owned or rented by member(s) of the household? (circle one)
How many rooms does the house have? _____
What is the square footage of the dwelling(s)? _____ m^2
How many windows does the house have? _____

	Foundation	**Exterior**	**Roof**
Construction Materials or Type			[Prompts: thatch, zine, tile]
	Kitchen	**Living Area**	**Transport**
Durables	[Prompts: stove type]	[Prompts: radio, TV, cell phone]	[Prompts: truck, car, motorcycle, bike, horse-cart]
	Cropland (hectares)	**Woodland (hectares)**	**Livestock and Pasture**
Other assets	_ own _ rent _____ annual _____ permanent	_____ regrowth ___ LR ___ PP _____ native forest ___ LR ___ PP _____ eucalyptus	[Prompts: horse, cattle, sheep, goats, chickens] _ own _ rent (pasture)
Service	**Type**	**Supplier**	
Water	_ piped and potable; _ well _ streams _ piped, not potable _ cistern	_ public utility _ private firm _ household	
Electricity	_ transmission line _ generator	_ public utility _ household _ private firm	
Sewerage	_ pit latrine _ toilet with septic tank _ toilet with sewerage connection	_ public utility _ private firm _ household	

2: Household Members

How many people live in this house? _____
How many people who contribute to household income don't live here? _____
How many people regularly eat in this house? _____
Has this number changed in the last eight years? _____
Does anyone who is not a family member regularly eat or cook food in this house? _____
If so, for how many years has this occurred? _____
What are the top 5 concerns for your household (rank from highest to lowest)? 1. _____, 2. _____, 3._____, 4. _____, 5._____
Does this household receive the Bolsa Familia (pro-poor entitlement)?

No.	Age	Gender	Relation to respondent	Current Residence and Activity	Income Earner or Sustenance Provider	Highest Education Obtained
1			Respondent		_ Yes _ entitlement _ No	
2					_ Yes _ entitlement _ No	
3					_ Yes _ entitlement _ No	
4					_ Yes _ entitlement _ No	
5					_ Yes _ entitlement _ No	
6					_ Yes _ entitlement _ No	

3: Fuel Uses

Daily Food/Drink Preparation	**Cooking**	**Baking**	**Heating Water**	**Other:**
On a typical day how many times do you use fuel to….. ?				
How many hours a day do you spend ……..?				
Which meals do you cook/ heat water for?				
Do you heat water for any purpose other than drinking?				
What type of fuel do you use to ……?	_ LPG _ Wood _ Charcoal _ Electricity _ Dung _Kerosene _ Other:	_ LPG _ Wood _ Charcoal _ Electricity _ Dung _Kerosene _ Other:	_ LPG _ Wood _ Charcoal _ Electricity _ Dung _Kerosene _ Other:	_ LPG _ Wood _ Charcoal _ Electricity _ Dung _Kerosene _ Other:
What is your preferred fuel for ….and why.?				
What species of wood do you use? Why?				
If you don't use your preferred fuel, why not?				
How long have you used this type of fuel for this activity? Why did you change?				
Does that quantity of fuel you use vary from the wet to dry seasons?				
How much wood do you use to _____ each day?				
In the last eight years, has the amount of wood you use to _____ with increased, decreased or stayed constant? If the frequency has changed, why do you think this is?	_ increased _ decreased _stayed same Why:	_ increased _ decreased _stayed same Why:	_ increased _ decreased _stayed same Why:	_ increased _ decreased _stayed same Why:
Lighting and Heating the Home	**Lighting**	**Heating**		
Do you light/heat your home? For how many hours a day? For how many months a year?	_ yes _ no _____ hours _____ months	_ yes _ no _____ hours _____ months		
What type of fuel do you use to light/heat your home? (check all that apply)	_ LPG _ Candles _ Electricity _ Kerosene _ Other:	_ LPG _ Wood _ Charcoal _ Electricity _ Kerosene _ Other:		

How long have you used this type of fuel?				
What did you use before and why did you change?				
What proportion of each fuel do you use to light/heat your house? Does this vary according to the season?	_ yes _ no	_ yes _ no		

4: Fuel Buying/Selling

Buying	Charcoal	Firewood	LPG	Candles	Other
Do you buy _____?	_ yes _no	_ yes _ no	_ yes _no	_ yes _no	
How much _____ do you buy each month?					
Where do you buy _____?					
What is the current price of a unit of this fuel? Does this price vary seasonally? How so?	_____ Reais _ yes _no	_____ Reais _ yes _no	_____ Reais _ yes _no	_____ Reais _ yes _no	_____ Reais _ yes _no
How much do you spend on _____ each month?	_____ Reais	_____ Reais	_____ Reais	_____ Reais	_____ Reais
How many hours would it take you to gather an equivalent amount of fuel?					
Selling					
Do you sell _____?					
When did you start selling _____?					
Where do you sell it?					
How much do you sell _____?					
Where do you get the _____ you sell?	_ make _ buy	_ gather _ buy			
If you make or gather the _____ you sell, how much wood do you collect each month for this purpose?					
If you purchase to _____ you sell, how much does this cost you each month?	_____ Reais	_____ Reais			
How many hours would it take you to					

gather an equivalent amount of wood?					
How much money do you make each month by selling _____?	_____ Reais	_____ Reais			

5: Fuel Types - Firewood

Over the last 8 years has the site(s) you collect firewood from changed in any of the following ways: (check all that apply)	_ different location(s) _ distance to site increased _ distance to site decreased _ frequency of preferred fuel species increased _ frequency of preferred fuel species decreased _ more people collect wood from this site _ fewer people collect wood from this site
	Firewood
What percentage of your firewood do you purchase and/or gather?	buying _____% gathering _____%
Gathering	
Where do you gather firewood from?	forest _____% coffee fields _____% regrowth _____% eucalyptus plantations _____%
How much wood do you collect each time? How long does this amount last you?	
Do you always gather firewood from the same place or from different places?	
How many kilometers do you have to travel to gather wood?	
Who gathers the wood?	
On which days and for how many hours a day does this (these) person (people) gather wood?	_____ days/week _____ hours/day
How much money could this person earn doing another activity for an equivalent amount of time?	_____ Reais _____ (activity)
How much firewood is collected each time?	
Does this vary depending on the season (dry/wet?)	_ yes _ no
Do you prefer to collect green or dry wood?	_ green _ dry
Do you prefer to collectwood from forests, regrowth, eucalyptus plantations or coffee fields? (Rank preferences) Why ?	__ forest __ regrowth __ eucalyptus __ coffee
How do you normally collect the wood?	_ pick up from ground _ cut branches from dead tree _ cut branches from live tree _cut down whole tree

5: Fuel Types – Firewood (continued)

Purchasing	
When did you start buying firewood? Why?	
How often do you buy firewood?	
How much firewood do you buy each time?	
In the last eight years, has the number of times you buy wood each year increased, decreased or stayed constant? If the frequency has changed, why do you think this is?	_ increased _ decreased _stayed same Why:
What type of wood do you buy?	_native species _ eucalyptus _coffee
What is your main concern about obtaining fuel for your family?	
In the past 8 years have you done any of the following?	_ planted trees to use as firewood _ conserved firewood _ shared firewood

6: Fuel Types – LPG and Others

Liquid Petroleum Gas (LPG)			
When did you start to use LPG? Why?			
How many bottles of LPG do you use a month for cooking?			
How does this number vary from the wet to the dry season?	_ increase wet _ decrease wet _ increase dry _ decrease dry _ does not vary with season		
Since 2000, has the amount of LPG you buy each month increased, decreased or stayed constant? If the frequency has changed, why do you think this is?	_ increased _ decreased _stayed same Why:		
Are you eligible for the "Gas Assistance" program? If so, does this influence your use of LPG?	_ yes _ no _ yes _ no		
Other fuel types			
In the last 8 years have you used any of the following fuels to cook or heat water?	_ coal	_ dung	_refuse
If yes: When?			
For how long?			
How much?			
From where?			
Has this changed over time?			
If no, why not?			

7: Atlantic Forest

Do you know what a Legal Reserve and Permanent Protection Area are?	_ LR PPA _ yes _ no _yes _no
Do you have a Legal Reserve or Area of Permanent Protection on your property? If so, are they legally registered?	_ LR PPA _ yes _ no _yes _no
Is there any Atlantic Forest on your property that is not a Legal Reserve or Area of Permanent Protection? If so, how many hectares?	_ yes _ no
Does anyone from your household use these forested areas for any of the following activities?	_ gathering firewood _ gathering building materials _grazing livestock _ cultivation _ other _____
In the last 8 years have you cleared any of the forest?	_ yes _ no
Does anyone from outside your household use these forested areas for any activities? With or without your permission?	_ gathering firewood _ gathering building materials _grazing livestock _ cultivation _ other _____
Are there any restrictions on use of Atlantic Forest? If so, what are they?	_ yes _ no
How do these restrictions affect your use of the forest?	_ 0 _ 1 _2 _3 _4 _ 5 Not in any way Somewhat Completely
How do these restrictions affect your household fuel choices?	_ 0 _ 1 _2 _3 _4 _ 5 Not in any way Somewhat Completely
Who monitors forest use?	

Who manages your forests?	
Rank the following activities as threats to the forests in this area on a scale of 0-5 with 1 being 'Not a Threat' and 5 being 'A Serious Threat'.	__gathering firewood __ gathering building materials __ grazing livestock __ cultivation __ burning grass nearby __ clearing __road construction __ mining __ restrictions on forest use __other

APPENDIX C

HOUSEHOLD SURVEY IN PORTUGUESE

O Uso Doméstico de Lenha na Zona da Mata Mineira, Brasil

Instrumento de Levantamento Residencial Socio-Económico (rev. 17 June 08)

Local: _____ (Comunidade)

Levantamento #:

Data: Entrevistor:

Data Entry:
Who:
Date:
Validation:
Who:
Date:

1: Residéncia Principal

A casa é própria ou alugada por membros da casa?
Quantos quartos tem a casa? _____
Qual é a metragem da casa? _____ m^2
Quantas janelas tem a casa? _____

	Fundação	**Exterior**	**Teto**
Materiais ou tipo de construção			[prompts: thatch, zine, telhas]
	Cozinha	**Sala de Estar**	**Transporte**
Bens	[prompts: tipo de fogão]	[prompts: rádio, tevê, telefone celular]	[prompts: caminhão, carro, motocicleta, bicicleta, cavalo-carro]
	Lavoura (hectares)	**Floresta (hectares)**	**Animais domésticos e pasto**
Outros Recursos **Total (ha)** **___Própria ___Alugada**	_ própia _ alugada _____ anual _____ permanente	_ própia _ alugada _____ capoeira ___ RL ___ PP _____ mata nativa ___ RL ___ PP _____ eucalipto	[prompts: cavalo, gado, carneiros, cabras, galinhas] _ própria _ alugado (pasto)

Servícios	**Tipo**	**Fornecedor**
Água	_nascente _poço _ conduzido, não potable _ cisterna	_ empresa municipal ou estadual _ empresa particular _ residência
Luz	_ linha da transmissão _ gerador	_ empresa municipal ou estadual _ empresa particular _ residência
Esgoto	_ latrine com fossa _ vaso com fossa séptica _vaso com esgoto sanitário	_ empresa municipal ou estadual _ empresa municipal ou estadual _ residência

2: Membros da Casa

Quantos pessoas moram nesta casa? _____
Quantos pessoas contribuem à renda desta casa mas não vivem aqui? _____
Quantos pessoas comem regularmente nesta casa? _____
Este número mudou nos últimos oito anos? _____
Alguem que não é membro familiar desta casa come ou cozinha aqui com regularmente? _____
Caso sim, faz quanto tempo que isto ocorre? _____
Quais são os cinco assuntos ou problemas mais importantes para sua casa? (colocar o mais importante primeiro)? 1. _____, 2. _____, 3._____, 4. _____, 5._____
Esta casa recebe a Bolsa Família? _____

No.	Idade	Sexo	Relação ao respondent	Residência atual e atividade (Use ou recolhe lenha?)	Fornecedor de renda ou sustento	Nivel educacional
1			Respondent		_ Sím _ Não _ Aposentadoria	
2					_ Sím _ Não _ Aposentadoria	
3					_ Sím _ Não _ Aposentadoria	
4					_ Sím _ Não _ Aposentadoria	
5					_ Sím _ Não _ Aposentadoria	
6					_ Sím _ Não _ Aposentadoria	

3: Usos de Combustível

Preparação diária do alimento/bebida	**Cozinhar**	**Forno**	**Esquentar Água**	**Outro:**
Num dia típico quantas vezes você usa o combustível para .. ?				
Quantas horas por dia você gasta … ?				
Para quais refeições você cozinha or esquenta água?				
Esquenta água por outro razão além de beber?				
Qual é seu combustível preferido para…. e por que.? Si é lenha, qual espécie(s)? Porque?				
Que tipo de combustível você usa para ……? Si é lenha, qual espécie(s)? Porque estas? Si não usa o combustível preferido, porque não?				
Faz quanto tempo que usa este combustível para esta atividade?				
Que usava antes?				
Porque mudou?				

3: Usos de Combustível (continuação)

Nos últimos oito anos, a quantidade de lenha que você usa para _____ tem aumentado, diminuído ou permanecido constante? Se a freqüência tem mudado, qual é a razão na sua opinião? → see comments on getting this more precise	_ aumentou _ diminuíu _não mudou Porque:	_ aumentou _ diminuíu _não mudou Porque:	_ aumentou _ diminuíu _não mudou Porque:	_ aumentou _ diminuíu _não mudou Porque:
A quantidade e proporções de combustível usada varia dependendo da estação?				
Quanto lenha usa para _____ cada dia?				

Iluminação e Aquecimento da Casa	**Iluminação**	**Aquecimento**
Ilumina ou aquece sua casa? Quantas horas por dia? Quantos mêses por ano?	_ sím _ não _____ horas _____ mêses	_ sím _ não _____ horas _____ mêses
Que tipo de combustível usa para iluminar/aquecer sua casa?	_ GLP _ Vela _ Electricidade _ Querosene _ Outro:	_ GLP _ Vela _ Electricidade _ Querosene _ Outro:
Desde quando usa este tipo de combustível?		
Porque mudou?		
Que proporção de cada combustível você usa para iluminar/aquecer sua casa? Isto varia de acordo com a estação?	_____ _ sím _ não	_____ _ sím _ não
O tipo de combustível que usa para iluminar/aquecer a casa mudou desde 2000? Caso sím, que tipo de combustível uso antes de 2000?	_ sím _ não _ GLP _ Vela _ Electricidade _ Querosene _ Outro:	_ sím _ não _ GLP _ Vela _ Electricidade _ Querosene _ Outro

4: Compra e Venda de Combustível

Compra	**Carvão Vegetal**	**Lenha**	**GPL**	**Vela**	**Outro [Luz]**
Compra _____?	_ sím _não	_ sím _não	_ sím _não	_ sím _não	
Quanto _____ compra cada mês?					
De onde compra _____?					
Qual é o preço atual de uma unidade deste combustível? Este preço varia de estacionalmente? Como?	_____ Reais _ sím _não	_____ Reais _ sím _não	_____ Reais _ sím _não	_____ Reais _ sím _não	_____ Reais _ sím _não
Quanto gasta em _____ cada mês?	_____ Reais	_____ Reais	_____ Reais	_____ Reais	_____ Reais
Quantas horas levaria para recolher uma quantidate de combustível equivalente?					
Venda					
Vende _____?					
Quando comecou a vender _____?					
A onde vende?					
Quanta _____ vende?					
De onde obtenha a _____ que vende?	_ faz _ compra	_ recolhe de: _ compra de:			
Se faz ou recolhe a _____ que vende, quanta madeira coleta cade mês para esta fin?					
Se comprar a _____ que vende, quanto isso lhe custa cada mês?	_____ Reais	_____ Reais			
Quantas horas lhe levaria recolher uma quantidade de lenha equivalente?					
Quantos reais ganha cada mês vendendo _____?	_____ Reais	_____ Reais			

5: Tipos de Combustível - Lenha

	Firewood
Qual porcentagem de sua lenha você compra e/ou recolhe?	comprar _____% recolher %
Gathering	
De onde recolhe lenha? Quanta lenha recolhe cada vez? Quanto tempo leva para recolher esta lenha? Esta quantidade serve pra quanto tempo?	mata _____% cafezais _____% capoeira _____% plantaçoões de eucalypto _____ % _____ _____
Sempre rocolhe lenha do mesmo lugar ou de diferentes lugares?	
Qual distância você tem que andar para recolher lenha?	
Quem recolhe a lenha?	
Quais dias e para quantos horas por dia este(s) individuo(s) recolhe(m) lenha?	_____ dias/semana _____ horas/dia
Quanto dinheiro esta pessoa poderia ganhar fazendo outra atividade por um período equivalente?	_____ Reais _____ (atividade)
Esta quantidade varia de acordo com a estação (verão/inverno?)	_ sim _ não
Prefere recolher lenha verde ou seca?	_ verde _ seca
Prefere recolher lenha da mata, capoeira, plantacões de eucalypto ou cafezais? (Indicar preferência) Por que?	__ mata __ capoeira __ eucalypto __ cafezais
Como recolhe a lenha? *If more than one method get percentages*	_ do chão _ cortar árvores mortos _ cortar árvores vivas _cortar árvores inteiras
Nos últimos 8 anos os locais de onde recolhe lenha tem mudado em alguma das seguintes maneiras:	_ local diferente _ a distância ao local aumentou _ a distância ao local diminuiu _ a freqüência da espécie preferida do combustível aumentou _ a freqüência da espécie preferida do combustível diminuiu _ mais gente coleta lenha deste local _ menos gente coleta lenha deste local

5: Tipos de Combustível – Lenha (continuação)

Purchasing	
Quando começou a comprar lenha? Por que?	
Qual é a freqüência que compra lenha?	
Quanta lenha compra cada vez?	
Nos últimos oito anos, a frequencia com que você compra lenha tem aumentado, diminuído ou permanecido constante? Se a freqüência mudou, por que você pensa que é?	_ aumentou _ diminuiu _permaneceu constante Why:
Que tipo de madeia voce compra?	_espécies nativas _ eucalypto _café
Qual é sua preocupação principal em relação á obtenção de combustível para sua casa?	
Nos últimos 8 anos voce tem feito alguma das seguintes atividades?	_ plantado árvores para lenha _ conservado lenha _ compartilhado lenha

6: Tipos de Combustível– GLP e outros

Gás Líquido de Petróleo (GLP)			
Quando começou a usar GLP? Porque?			
Quantos botijões de GLP você usa num mês cozinhando? ~kg?			
Como varia esta quantidade com as estações?	_ aumenta molhada _ aumenta seca _ não varia com estação	_ diminui molhada _ diminui seca	
Desde 2000, a quantidade de GLP que compra cada mês tem aumentado, diminuído, o permanecido igual? Se a frequencia tem mudado, por quanto e por que voce pensa que é?	_ aumentado _ diminuído _permanecido igual Porque?		
Você é eligible para programa do auxílio gás? Qual influência tem este programa no seu uso de GLP?	_ sím _ não _ sím _ não		
Outros Combustíveis			
Nos últimos 8 anos tem usado qualquer dos seguintes combustíveis para cozinhar ou aquecer água?	_ carvão mineral	_ dung	_dejetos
Caso sím: Quando?			
Para quanto tempo?			
Quanto?			
De Onde?			
Tem mudado com o tempo?			
Caso não, porque?			

7: Mata Atlântica

Sabe o que é uma Reserva Legal e uma Área de Proteção Permanente?	RL: _ sím _ não APP: _ sím _ não
Tem uma Reserva Legal ou Área de Proteção Permanente na sua propriedade? Caso sím, são averbadas? Quantos hectares são?	_ RL _APP _ sím _ não _ sím _ não _____ hectares
Tem alguma area de mata nativa na sua propriedade que não seja Reserva Legal ou Área de Proteção Permanente? Caso sim, quantos hectares?	_ sím _ não _____ hectares
Algún membro de sua casa usa estas areas florestadas para qualquer das seguintes atividades?	_ recolher lenha _ recolher material de construção _pastagem _ lavoura _ outra _____
Nos últimos 8 anos tem desmatado qualquer area florestada?	_ sím _ não
Algúem que não seja de sua casa usa estas areas florestadas para qualquer das seguintes atividades? Com ou sem seu permisso?	_ recolher lenha _ recolher material de construção _pastagem _ lavoura _ outra _____
Existe qualquer restrição no uso da Mata Atlântica? Caso sim, quais são?	_ sím _ não
Estas restrições influenciam no seu uso da mata?	_ 0 _ 1 _2 _3 _4 _ 5 Não afeta Parcialmente Completamente
Estas restrições influenciam na sua escolha de combustível domestico?	_ 0 _ 1 _2 _3 _4 _ 5 Não afeta Parcialmente Completamente
Quem fiscaliza a floresta na sua propriedade?	
Quem maneja a floresta na sua propriedade?	
Colocar as seguintes atividades como ameaças à Mata Atlântica nesta região numa escala de 0 a 5 com 1 sendo 'não uma ameaça' e 5 sendo 'uma ameaça grave'.	__ recolheito de lenha __ recolheito de materiais de construção __ pastagem __ cultivo

	__ queima de grama __ desmatamento __construção de estradas __ mineração __ restrições no uso da mata__ outro

APPENDIX D

ISSUES APPEARING IN ROSÁRIO DA LIMEIRA CASE STUDY

Participant	Effort (min/day)	Hectares owned	Ha of FW (access)	Category Transport	Number in household	Cell Phone	≥ 1 regular income	Wife employed	Husband finished HS	Wife finished HS	Welfare	Minor Topics	Quotes, Impressions
SG01	2.67	n/a	n/a	2	4							1. Eucalyptus use	Uses solely eucalyptus fw.
SG02	16.0	30.0	18.5	2	3						X	2. Coffee use (as fw)	Switched to eucalyptus 8 years ago because didn't want to continue cutting down natives
SG03	4.0	30.0	18.5	3	3		X					3. Water scarcity 4. Charcoal production 5. Adherence to AF policy	Many springs are drying up and people are worried now about water. 10 years ago her husband deforested some of his property to sell as charcoal and he was fined. Prefers to use native species to cook, but mostly uses eucalyptus because

													"they (IBAMA) say it's forbidden to take wood from the forest". Wishes that people had more freedom to use resources from forest. But "most people don't respect the restrictions on the forest."
SG04	17.14	14.0	5.0	4	5	X						2. Coffee use (as fw)	Is not affected by AF restrictions because does not need to use wood from native species
SG05	16.0	9.0	5.2	2	3						X	5. Adherence to AF policy	Aware that you're not supposed to cut natives from forest, but uses 100% native species as fw. However, claims that all this wood is found fallen on forest floor.
SG06	2.67	16.0	5.0	5	4	X						5. Adherence to AF policy	Again, uses mostly native tree species, but says that they are collected from the forest floor because cutting down native trees is prohibited
SG07	8.0	7.5	3.0	3	4						X	6. Understanding of AF policy	Was unaware of any restrictions of use of

													forest resources, nevertheless 80% of fw is eucalyptus.
SG08	16.0	7.5	3.0	2	3	X	X					3. Water scarcity 7. Fuel preference	Says she doesn't like cutting down native trees because of the springs. Prefers to use LPG to cook, uses eucalyptus when uses fw.
SG09	4.0	15.0	8.5	2	2							1. Eucalyptus use 6. Understanding of AF policy	Has used eucalyptus for 20 years, but continues to use some wood from the forest Believes that households can take wood from forest for domestic use, but can't deforest property
SG10	n/a	11.0	1.0	2	4	X					X	3. Water scarcity 6. Understanding of AF policy	Nowadays people are afraid of running out of water. Uses only wood from native species, even though she knows that it is illegal to cut down trees in forest. Says that the permit required to cut trees from forest is so difficult to get that people don't even try.

SG11	51.43	6.0	0.5	5	7		x				X	6. Understanding of AF policy	Uses wood from native species. Allowed me to accompany him to collect wood. Cuts only dead trees, but is not aware that even this is illegal. Is aware that people can be fined for deforesting too much.
GR01	32.0	27.0	11.0	4	3		X					8. Influence of environmental education programs/ NGO	12 years ago became aware of importance of conserving forest
GR02	n/a	0.0	4.0	2	3		X					6. Understanding of AF policy 9. Land ownership 10. Impact of fw use on ecosystem.	Don't own land and are afraid to invest in it. Completely unaware of AF policy; uses native species as fw, sometimes cut green.
GR03	34.29	27.0	5.5	2	6							8. Influence of environmental education programs/ NGO	Values forest conservation
GR04	1.33	9.0	3.5	5	3	X	X					6. Understanding of AF Policy 8. Influence of environmental education programs/	About 15 years ago people began to pay more attention to forest laws for several reasons: education, law

												NGO	enforcement and water supply. Most people now obey the forest laws because they understand that they are in their best interest, but there are some uneducated people who don't.
GR05	4.0	0.0	8.0	1	2							2. Coffee use (as fw)	This was one of the least talkative interviewees.
GR06	15.0	3.0	1.5	3	2	X	X	X				2. Coffee use (as fw)	Prefers to use coffee as fuelwood, but nowadays used more eucalyptus because people are growing less coffee.
GR07	n/a	12.0	4.5	2	11		X				X	6. Understanding of AF Policy	Uses mostly native species. Doesn't like eucalyptus because he thinks it uses too much water. Doesn't believe that native forests protect the springs. Nowadays people are letting the forest grow back rather than keeping their land "clean", because of the law. Has an unfavorable opinion of the forest laws, but recognizes that without them there probably

													wouldn't be any forest left.
GR08	34.29	24.0	12.5	2	2		X					6. Understanding of AF Policy 8. Influence of environmental education programs/ NGO 11. Fuelwood scarcity	Believes that the forest law permits households to gather wood for domestic use, but not to sell. 50% of his fw comes from natives species, but gathered from the forest floor, not cut from green trees. Seu Joaquim has helped Robin to educate people about monitoring their properties (they are in the buffer zone of the state forest and IEF initially wanted to remove them from their properties). Says there is actually more wood now because there is more forest and fewer people gathering wood.
GR09	17.14	n/a	n/a	2	4						X	6. Understanding of AF Policy	Uses natives, eucalyptus and coffee. Says that you have to get a permit to deforest.
GR10	32.0	0.0	6.5	2	3	X	X					6. Understanding of AF Policy	Believes that the law protecting the forest is good.

GR11	4.0	0.0	20.0	3	3	X						1. Eucalyptus use 12. Wood selling	Live on eucalyptus plantation, use only eucalyptus Landowner (Robin) sells eucalyptus to a buyer who takes wood to a dairy product factory
GR12	64.0	3.0	1.0	2	5		X					3. Water scarcity 6. Understanding of AF Policy	Says it's illegal to deforest. Uses 30% native species, but never cuts live trees. She says people stopped deforesting because of the law, but also because of water scarcity.
SP01	n/a	30.0	23.0	5	2		X					6. Understanding of AF Policy	Despite being the Secretary of Agriculture, Valdeli (interviewee's son) didn't know many specifics about the AF policy, such as the difference between APPs and RLs. Valdeli's wife is a teacher and only cooks with gas.
SP02	2.4	64.0	8.0	4	2		X					6. Understanding of AF Policy 12. Wood selling 13. Forest fragmentation	One of the only households to understand the difference between RLs and APPs and to have both on property. But says

												14. Access to city/opportunities	many people don't respect the AF policy because they aren't afraid of being fined. Also sells eucalyptus to dairy producer. Living in one of the most affluent and deforested communities, she says that she uses mostly eucalyptus now because there isn't much native forest left on her property.
SP03	16.0	21.0	19.0	2	5		X				X	13. Forest fragmentation	Says it's very difficult to find good wood in the forest.
SP04	8.0	5.0	2.0	3	6	X						6. Understanding of AF Policy	Says there are no restrictions of use of forest resources and uses 100% native species for fw.
SP05	3.0	12.0	1.0	4	3	X	X	X	X	X		14. Access to city/opportunities 15. Education 16. Women working outside home	Both wife and husband completed high school and are employed fulltime in the city. The wife frequently uses gas for cooking, but still uses some fuelwood, some of which is gathered from the forest, even though she said that the

													prohibits cutting any tree from the forest and that she thinks it's a fair law.
SP06	10.0	27.0	6.0	4	3	X						7. Fuel preference	Uses only native species for cooking, doesn't use eucalyptus because it "spits".
SP07	n/a	3.0	1.0	5	3	X	X	X	X	X		8. Influence of environmental education programs/ NGO 12. Wood selling 15. Education 16. Women working outside home	Sells eucalyptus Both wife and husband completed highschool and work for the local government. Uses wood only when she has time, mostly uses gas. Says that the local government, Ircambi, and TV have helped make people more aware of the value of conserving the forest. She says that people have to realize that you can't cut down any more trees, you have to plant them. And more people have realized that it's more worth their time to buy gas than to look for wood.
SP08	8.57	15.0	4.0	5	2	X	X	X				16. Women working outside home	Since she has started working in the city uses less wood. But

													still prefers to use wood to save money on gas.
SP09	n/a	18.0	4.5	4	3		X					1. Eucalyptus use 13. Forest fragmentation	One of the oldest inhabitants of Sao Pedro, with lots of offspring living there. Most of his land is pasture, but he has preserved some trees in the pasture, from which he gets all his fuelwood. But also has 2000 eucalyptus trees which he received from the Promato program.
SP10	4.0	15.0	4.0	5	3	X	X					6. Understanding of AF Policy	Gets all fuelwood from forest, but cuts only dead trees, which he says is legal. At first interview was very talkative and agreed to let me do a focal follow, but when I returned the next week he was very different and said he didn't have time.
SP11	n/a	0.0	0.0	3	3	X	X					7. Fuel preference	The only household

												9. Land ownership	interviewed that didn't use any fuelwood at all. She said it was because she preferred cooking with gas, but she also didn't have any land with forest.
SP12	17.14	9.0	1.0	2	3		X					13. Forest fragmentation	No native forest on property at all (most others had at least some capoeira). Has a small eucalyptus grove that supplies fw.
SP13	42.86	0.0	0.0	2	6	X					X	6. Understanding of AF Policy 9. Land ownership	Rents one acre of land without any forest. Prefers to use wood, but can't always get any. Has to travel far to another property of her landlord where she is allowed to gather wood. So, frequently has to buy gas, even though her family does not have any regular income, other than the Bolsa Familia. Was one of the only households to express concern over wood supply, because she has to travel over an hour to access it. The wood

													she does get is native, she says the law does not allow the cutting of live trees but that you can cut dead ones.
SA01	0.0	15.0	8.0	3	2	X	X		n/a	X		12. Wood selling 17. Mining	Sometimes sells eucalyptus for buyers. Once a year pays workers to gather wood for her. Says now people are planting trees to protect their land from mining companies.
SA02	17.14	7.0	4.5	3	4						X	1. Eucalyptus use	Planted eucalyptus from Promata for domestic use.
SA03	34.29	9.0	0.5	1	5		X					13. Forest fragmentation	It used to be easier to find native fw, but a few years ago her neighbor cleared his forest for pasture.
SA04	12.0	0.0	126.8	3	2	X	X		X	X		2. Coffee use (as fw) 6. Understanding of AF Policy 9. Land ownership	Doesn't own land, but is the main caretaker on 360 hectares and has access to wood from forest, coffee and eucalyptus. For having so much wood, spends a lot of time gathering per day, but maybe that's because he is often

													clearing wood for other purposes. Uses mostly coffee for fw. Even though employer participates in Promata, he (employee) doesn't know that there are any restrictions on AF resources.
SA05	4.29	0.0	126.8	2	5		X				X	6. Understanding of AF Policy 9. Land ownership	Husband works for same big landowner and they have access to all the resources. Uses native species as fw. Believes that only green trees are restricted.
SA06	68.57	3.0	1.05	3	3							2. Coffee use (as fw) 6. Understanding of AF Policy 13. Forest fragmentation	Uses coffee as fw because it's more convenient and she doesn't like to go into the forest. Says that it used to be easier to get wood because there used to be more forest. Says that there are no restrictions on AF use, but the Forest Police don't like people to cut it.
SA07	4.0	30.0	1.0	1	3		X	X				16. Women working outside home 18. Price of gas	Uses mostly gas to cook with because its faster and she is not home during the day (she works at a

													school in Limeira). She is concerned with the price of gas because she can't always afford it.
SA08	16.0	n/a	n/a	2	4		X				X	6. Understanding of AF Policy 7. Fuel preference 19. Wood purchasing	Sometimes purchases wood from neighbor. Also gather's native wood from employer's forest. Says there are no restrictions on AF resources. Doesn't use any gas at all.
SA09	n/a	0.0	0.5	4	4		X				X	6. Understanding of AF Policy	Collects native species for fw from neighbors land. Says that you can't deforest, but it's ok to cut trees.
SA10	n/a	0.0	50.0	4	8		X				X	3. Water scarcity 13. Forest fragmentation 19. Wood purchasing	Works on large property, but none of it is forest. Buys wood from neighbors or in city. Says the laws that protect the forest are good because if they weren't there, there would be no forest, and then there would be no water.
SA11	n/a	30.0	3.3	3	3							1. Eucalyptus use 2. Coffee use (as fw)	Doesn't buy gas. Uses coffee and eucalyptus.
SA12	8.57	0.0	15.0	2	3		X				X	1. Eucalyptus use	Works on property

													that is mostly eucalyptus. The owner plans to cut down his coffee to plant eucalyptus.

VITA

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