Population Dynamics and the Environment:

Examining the Natural Resource Context of the African HIV/AIDS Pandemic

Lori M. Hunter
Institute of Behavioral Science
Program on Environment
University of Colorado at Boulder, USA

Wayne Twine
Centre for African Ecology
University of Witwatersrand, South Africa

Aaron Johnson
Department of Sociology
University of Colorado at Boulder, USA

Direct correspondence to Dr. Lori Hunter, Lori.Hunter@colorado.edu. This manuscript has been prepared as a working paper for the Biannual meeting of the International Union for the Scientific Study of Population to be held July 2005, Tours, France and is available as a working paper through the Institute of Behavioral Science at the University of Colorado at Boulder: http://www.colorado.edu/ibs/pubs/working_papers.html. The research presented herein has been supported by the Programme on Population, Environment, and Development (PRIPODE) of the Committee for International Cooperation in International Research in Demography (CICRED). Supplemental funding was received through the Population Aging Center at the University of Colorado at Boulder (NIA 5-P-30-AG017248). We thank Elly Mokoena for his assistance with fieldwork, Amy Vreeland for her assistance with data analyses, and the staff and residents of the Agincourt Health and Population Unit for their support and participation in this project.

Population Dynamics and the Environment:

Examining the Natural Resource Context of the African HIV/AIDS Pandemic

Abstract: There is a significant lack of research as to how demographic dynamics interact to shape household use of natural resources in less developed regions. This information is, however, key to understanding the complex interactions between humans and the environment, particularly given the centrality of the natural environment within rural livelihoods. Within the rural African context, natural resources also act as a buffer against household shocks, offering for example, a potential means of generating income and/or meeting dietary needs. In this study, we focus on HIV/AIDS mortality as a particular household shock, examining natural resource use, specifically fuel wood strategies, as shaped by households' mortality experience. In the year 2000, 21.5% of deaths in the study region of South Africa's Lampoon Province were attributed to AIDS. It is projected that by 2010, this will rise to nearly 65 percent. Making use of both quantitative and qualitative data, we respond to the following two research questions: *1) What are the associations between household size, composition and economic status, and natural resource use in rural South Africa?; 2) Beyond these household characteristics, how is mortality experience associated with the ways in which households use key natural resources?* Our analytical focus is on households that have experienced the recent death of a household member in the most productive age group (15-49). As for results, the quantitative analyses suggest the importance of socioeconomic status and local resource availability in shaping household resource use after adult mortality, while the interviews provide insight into the more nuanced stories of coping strategies following the loss of an adult household member. In general, the study's results begin to shed light more generally on the environmental dimensions of the HIV/AIDS pandemic, while also providing an important foundation for future analyses.

Population Dynamics and the Environment:

Examining the Natural Resource Context of the African HIV/AIDS Pandemic

Two important trends in population and the environment are presently colliding to shape the sustainability of rural livelihoods in many of the "lesser developed" regions of the world. The first such trend is an alarming rise in adult mortality largely attributed to the HIV/AIDS pandemic, especially in rural sub-Saharan Africa. The second trend is a similarly troubling perpetuation of environmental degradation. Taken together, the trends of rising adult mortality and continuing environmental degradation pose severe threats to rural sub-Saharan African livelihoods, and yet despite increasing HIV/AIDS prevalence and the fact that natural resources represent a central component of rural African livelihoods, the environmental dimensions of the African HIV/AIDS pandemic have received little scholarly attention. It is this gap that has motivated the present work and, as such, this paper is meant to contribute to our nascent understanding of the ways in which natural resource use in poor, rural regions of developing nations is being shaped, and re-shaped, by the loss of productive adult household members. With a particular focus on the household use and collection of fuel wood, and through examination of both quantitative and qualitative data, this paper explores two important research questions: 1*) What are the associations between natural resource selection, use, collection and consumption strategies and the household characteristics of size, composition and economic status in rural South Africa? 2) Beyond these household characteristics, how is adult mortality experience associated with the ways in which households select, use, collect and consume key natural resources?*

The manuscript is organized in the following manner: first, it offers a brief review of the literature on the centrality of natural resources in rural household livelihoods, and a concise look at mortality trends especially as related to HIV/AIDS. These two areas are then brought together in

presentation of our research questions and consideration of the various ways in which rural households' natural resource use and collection strategies might be altered by an adult mortality experience. Next the details of the research setting, data collection, and analytical methods are presented. Last is the presentation and discussion of the research findings, which includes explicit links between observed associations and important policy implications for both public health and environmental conservation.

Natural Resources and Rural Livelihoods in Developing Nations:

In many regions of less developed countries, rural households depend upon a range of natural resources for basic living requirements (Koziel and Sanders 2001; Shackleton et al. 2001). Within these regions, important land-based activities include arable farming, livestock husbandry, and consumption and trade in natural resources (e.g., fuel wood, wild herbs, vegetables) and although such activities are critically important to rural livelihoods in both financial and social terms, this resource dependence typically escapes national economic accounting systems (Shackleton and Shackleton 2000). Such oversight occurs because natural resources are often collected for domestic consumption and/or are traded informally (Stiles 1994; Qureshi and Kumar 1998).

To assess the importance of natural resources to rural livelihoods, several studies have aimed to document the level of consumption and direct-use value of natural resources; A summary of seven such case studies in South Africa is provided by Shackleton et al. (2001). The review suggests that the gross value of consumed natural resource products varies from approximately R2300 ($350 / €280) to over R7200 ($1100 / €880) per household. Indeed, some suggest that the total direct use value of natural resources is equal to the mean value of rural South African household state pensions (Twine et al. 2003).

While households do not typically incur financial cost for the acquisition of communal natural resources, there are other costs associated with natural resource collection. Specifically, collection takes time and therefore, reduces time available for other forms of contribution to the household including income-generating activities. As a specific example, rural Nepalese women have been observed

spending over 4 hours a day collecting natural resources (i.e. fuel wood, leaf fodder, and cut grass), time that reduces the labor available for other vitally important household activities including the care of children (Cooke 1998). Results of research in this area suggest that when environmental conditions deteriorate, women and children, in particular, "pay a high price" (Cooke 1998). Similar patterns characterize rural Pakistan, where evidence suggests that poor water infrastructure induces women to reduce their market-oriented work, and thus, their contribution to household income (Ilahi and Grimard 2000).

The importance of natural resources to rural livelihoods further implies that natural resources also play a vital role as a "safety net" against destitution (Letsela et al. 2002:352; Shackleton and Shackleton 2004; Shackleton et al. 2001; Twine et al. 2003). As evidenced in a study by Twine et al. (2003), even in rural South African villages where electricity is readily available, over 90% of households used fuel wood as their primary energy source for cooking and heating due to the prohibitive costs of electricity and electrical appliances. Additional research in Lesotho (Griffin et al. 1993) and throughout Africa (ABCG 2002) supports such findings in suggesting that, in general, natural resources offer an inexpensive alternative (in financial terms) to otherwise purchased goods (Griffin et al. 1993; Letsela et al. 2002). It is within this association that we find an important link with mortality. Specifically, shifts in resource use and collection strategies may be anticipated as changes in household size, composition and, potentially, socio-economic status are experienced resultant of an adult mortality experience. Following a short overview of African mortality trends generally, a typology of the various ways in which natural resource use and collection strategies might change is presented.

Mortality Trends and HIV/AIDS in Africa:

Unfortunately, dramatic declines in life expectancy, due primarily to HIV/AIDS, characterize the population of many African nations. Indeed, HIV/AIDS is the leading cause of death worldwide for people aged 15 to 49, with 37.8 million individuals (estimated range 34.6 – 42.3) infected with HIV as

of 2003 (UNAIDS 2004a). Nearly 5 million people were newly infected with HIV during 2003, and nearly 3 million died during that same year (UNAIDS 2004a). While indeed staggering on a global scale, southern Africa has been called the "epicenter" of the HIV/AIDS pandemic (United Nations 2004b:8). Specifically, sub-Saharan Africa, with 10% of the world's population, is home to 70% of all people living with HIV/AIDS, although prevalence rates appear to have stabilized at the level of 2 million new infections annually (UNAIDS 2004b).

Within sub-Saharan Africa, the southern region remains the most-affected, while South Africa, is characterized by 21.5% prevalence, a mid-range prevalence for the region. The region's highest prevalence rate is found in Swaziland (38.8%) and lowest in Zambia (16.5%) (UNAIDS 2004b). Within South Africa, our study area is in the Limpopo Province, the most northerly of South Africa's nine provinces, where HIV-related tuberculosis and lower respiratory tract infections are among the leading causes of death (Thom 2004). Unfortunately, health indicators for the province suggest that the impact of HIV/AIDS is only beginning to be felt. In the Limpopo Province in the year 2000, 21.5% of deaths were attributed to HIV/AIDS. It is projected that by 2010, this will rise to nearly 65 percent (Day and Gray 2003). Indeed, South African health services are feeling the impact of the AIDS epidemic, but sadly this is only likely to get substantially worse in the next 5-10 years (Johnson et al. 2003). In all, the study area represents an appropriate and important context in which to examine the implications of HIV/AIDS. Once a mainly urban phenomenon, HIV/AIDS has become a "formidable social problem" in rural Africa, with major implications for rural development (Vogel 2002; Rugalema and Khanye 2002; Hargreaves and Pronyk 2003).

It is well-known that HIV/AIDS disproportionately kills adults in their prime economic and parenting years (de Waal and Whiteside 2003; Haddad and Gillespie 2001). Thus, as noted by Hargreaves and Pronyk "rural households are highly vulnerable to the multiple impacts of the illness and death of a household member" (2003: 94). More so, it is the intersection of the demographic, cultural and economic characteristics of HIV/AIDS that makes it such a devastating "shock" not only for

afflicted households, but also more generally for communities, organizations, institutions, and even entire societies. As noted by Beresford, "HIV/AIDS damages society just as it does the human body: it begins by killing those parts responsible for building society, the women and breadwinners who sustain and safeguard the community as a whole" (2001:19).

Mortality and Household Use of Natural Resources

Generally speaking, rural households undertake many unique and nuanced changes with regard to natural resource use and collection strategies following an adult mortality experience. Following the lead of similar research in the area (i.e., ABCG 2002; DIA 2003), the myriad possible changes a household may make are presented here as a typology of four interrelated dimensions of household strategies involving the selection, use, collection, and level of consumption of natural resources..

Natural resource selection strategies include those household decisions involving what natural resource is to be used for a given purpose. For instance, mortality-induced changes in natural resource selection have been observed as afflicted households turn to natural resources (e.g., wild foods) as alternatives to purchased items (ABCG 2002; Barany et al. 2001). More generally, mortality effects on resource selection strategies can be seen as more desirable products are replaced with those most readily available as households struggle to cope with diminished labor capacity and the resultant reallocation of money and time (ABCG 2002). For example, women in rural India have been observed using bamboo as fuel wood despite its low sustained heat, fast burn rate, and excessive smoke due to "extreme difficulties" obtaining the preferred species of fuel wood (TERI 1994).

Closely related to selection strategies, *natural resource use strategies* are decisions regarding the purpose of the selected natural resources. As examples, household use strategies may include using dung as fuel rather than as fertilizer. Also, use strategies may entail the sale of natural resources otherwise used for household consumption in an effort to raise much needed income (Cooke 1998). Similarly, reassessment of the use of land for income-generating or subsistence crops, as well as

decisions to leave land fallow would be considered changes in natural resource use strategies (ABCG 2002).

Natural resource collection strategies represent another important arena of potential change. More specifically, natural resource collection strategies involve those decisions regarding *where* natural resources are to be collected (including formal and informal markets), *who* (in terms of household position) will do the collecting, and the associated *costs* of collection in terms of time, money and/or bartered assets. For example, natural resource collection may take place within communal lands, within a homestead garden, and/or natural resources may be purchased or received as gifts. Filmer and Pritchett (1996) provide a particularly salient example of the importance of collection strategies. Their research from Pakistan suggests that fertility rates may rise in response to resource scarcity due to an increase in the relative value of children as resource collectors, for as has been noted "little hands help" (das Gupta 1995). Accordingly, the subsequent rise in population can further contribute to natural resource scarcity, in all creating a rather insidious "vicious circle" of increasing population and natural resource scarcity (Filmer and Pritchett 1996).

As related to mortality experience, the Africa Biodiversity Collaborative Group (ABCG) reports that throughout sub-Saharan Africa changes in the natural resource collection strategies frequently involve unsustainable collection practices and the de-emphasizing of stewardship in general (ABCG 2002). Unfortunately, the death of a prime-aged adult also often represents the loss of a skilled and knowledgeable natural resource collector. In contrast, children and inexperienced natural resource collectors are more likely to employ unsustainable collection practices due to a lack of (often traditional) knowledge (ABCG 2002; DIA 2003).

Questions of *who* in the household collects resources unavoidably raise the issue of opportunity costs. Indeed, increases in time spent on natural resource collection as a result of an adult collector's death represent only a part of households' collection costs. Opportunity costs are also incurred as other activities are left unattended due to the reallocation of time. A summary of research from sub-Saharan

Africa notes that time otherwise spent in school or studying represents significant opportunity costs associated with the use of children as natural resource collectors (DIA 2003). Similarly, the diversion of adults from income-generating activities to assist with the collection of necessary natural resources represents a significant opportunity cost (Cooke 1998).

Other aspects of change in natural resource collection strategies include the monetary and bartered costs of obtaining necessary natural resources. For example, monetary funds may be reallocated, or household assets liquidated, in order to purchase requisite natural resources when collection from the natural sources is impossible (ABCG 2002).[1] Additionally, research reveals increases in begging and a greater reliance on family and charitable organizations, following the death of a household member (Mutangadura et al. 1999).

Finally, *natural resource consumption strategies* refer to changes in quantities of resources consumed. Mutangadura et al. (1999) find that households generally reduce their overall level of consumption of natural resources in conjunction with related changes in natural resource selection and collection strategies. Still, it should be noted that such reduced consumption may be less of a "*strategy"* and more of a necessity than is suggested by the typology used here.

Clearly, natural resource selection, use, collection and consumption strategies of rural South African households are quite complex. This project aims to explore these strategies, with a particular focus on the ways in which they may be reshaped by the death of an adult household member.

Study Context and Methods:

The fieldwork for this project was undertaken at the Agincourt Health and Population Unit's (AHPU) field site during May-June 2004 in a rural region in the extreme northeast of South Africa (see Figure 1). The AHPU encompasses 400 sq. km. approximately 500 km. northeast of Johannesburg, including 21

[1] This is, unfortunately, a common strategy to cover medical and/or funeral costs as well (ABCG 2002; DAI 2003; Mutangadura et al 1999).

villages and over 11,000 households. The area is dry (annual rainfall 550-700 mm) and relatively heavily populated (~170 persons per sq km). Household plots are typically too small to fully support subsistence agriculture. The settlement pattern is fairly typical of rural communities across South Africa, and socio-economically is characterized by a high reliance on both natural resources and remittances from a large migrant population. Indeed, there is limited formal sector employment and, as such, a large proportion of adults are migrant laborers, working on commercial farms and in towns and cities across the country. Of all males between the ages of 30 and 49, 50% are migrant workers, as are 14% of females of the same age group. In addition, a significant proportion of households depend on the state pension of an elderly resident as the only reliable source of household income. As noted, residents of these rural communities are typically dependent on the natural environment for a range of uses, including the grazing of livestock and the collection of fuel wood, wild foods, thatching grass, construction timber, and other domestic products that are used for both household consumption as well as for generating income (Shackleton 1996; Shackleton and Shackleton 2000).

(Figure 1 about here)

Information on the incidence of mortality, as well as other demographic characteristics of Agincourt households, was available through the AHPU's longitudinal demographic surveillance system (DSS). Since 1992, the AHPU has collected census data at 12-18 month intervals from all 11,000 households in the Agincourt subdistrict. Given the importance of HIV/AIDS as a factor shaping contemporary mortality patterns, this study focuses on households having experienced the death of a household member aged 15-49 during the 2 years prior to our fieldwork. Individuals within this age group are especially vulnerable to AIDS and also most likely to be either economically productive and/or engaged in regular natural resource collection. We undertook a natural resource survey with 240

households in 8 villages in the central region of the study site.[2] The sample was stratified by mortality experience, half of the survey households were randomly selected from village households having experienced the death of a household member aged 15-29 in the past 2 years. Half were selected from households experiencing no such mortality. The survey focused on both fuel wood and water, and queried as to household selection, collection, use, and consumption patterns at present and five years prior.[3]

In addition, we undertook interviews in 31 of the surveyed, mortality-impacted households. These interviews ranged in length from 30-90 minutes, and we spoke with the household member most engaged in resource collection. The interviews were conducted primarily by project investigators, with the assistance of a local translator. All interviews were translated and fully transcribed. For the purposes of this manuscript, we carefully reviewed the text of each conversation with an eye toward identifying 1) patterns related to the selection, use, collection and level of consumption of natural resources within the household, and 2) changes in the strategies for selection, use, collection and consumption of natural resources following the death of an adult household member, particularly the ways in which natural resources are incorporated in coping strategies. As reviewed in the following section, the interview data supplement the survey results thereby providing a more nuanced understanding of the association between mortality and household management of natural resources in rural South Africa.

Quantitative modeling of the survey data makes use of information collected with regard to households' use of wood and alternative forms of energy, namely electricity. We query as to the types of uses (cooking, heating bath water, heating the home, brewing traditional beer), level of use by season

[2] Geographic restrictions were due to logistical and budgetary considerations. Nonetheless, the study villages were chosen to represent a range of environmental context along the region's east-west rainfall gradient.

[3] As should be clear from this description, our methods did not distinguish *a priori* households experiencing only HIV/AIDS mortality. Rather, our focus is on households experiencing the loss of an adult household member in the prime working years. As such, we explore mortality impacts more broadly, although with an eye toward better understanding of the household impacts of HIV/AIDS mortality in Africa as well as the increasing incidence of HIV/AIDS mortality within our study region.

(in kg), and acquisition strategies (purchase, harvested by specific household members). In the analyses that follow, all outcome variables, except amount of fuel wood used, are coded as dummy variables with 1 reflecting "yes" to the activity/outcome measured. Importantly, the outcomes are not mutually exclusive given the complexity of household livelihood strategies. For example, a household may be coded "1" for purchases wood, while also being coded "1" for both the female head and daughter being wood harvesters.

Our primary predictors of interest reflect household experience with adult mortality in the 2 years prior to the survey. A dummy variable reflects households impacted by adult mortality, while an interaction term tempers the mortality estimate according to time since the mortality experience. An additional interaction term reflects variation in mortality impacts across households by socio-economic status as reflected by the possessions index.[4]

Our control variables are those which allow examination of our specific research questions. We include household size as a categorical variable based on preliminary analyses and for ease of interpretation (categories reflect household size of 1, 2-5, 6-10, greater than 10). Three variables reflecting household composition are also included. Sex ratio is measured in standard demographic form as male:female, while young and old age structures are also reflected. A household is coded as characterized by a young age structure if at least 1/3 of its members are under age 15, while an older age structure is noted if at least 1/3 of a household's members are over age 50. Finally, a "possessions index" has been created within the Agincourt Health and Population Unit to reflect socio-economic status. The index ranges from 1 to 5 and is derived annually within the DSS from an asset register including presence of a tap and toilet on the household stand, as well as ownership of appliances (e.g. radio) and equipment (e.g. wheelbarrow).

[4] Additional predictors related to household mortality experience were explored (e.g., gender of deceased, non.linear representation of time since mortality). The most robust and parsimonious models are presented.

Table 1 presents a descriptive profile of the study's survey sample. As characteristic of the study region generally, the vast majority of households use fuel wood, with most using wood for cooking and heating water for bathing. It is far less common for households to make use of wood for heating the home or brewing traditional beer and, as such, these are not presented as outcome variables in the multivariate models. Even with the high level of dependence on fuel wood, it is clear that most households are electrified as over ¾ make use of electricity for lighting. Nearly 1/3 use electricity for cooking purposes, although clearly this is supplemental energy given the high level of wood use also apparent. There is a wide variation across households in level of wood used, although only about 1.5 kg seasonal difference. On average, households use nearly 9 kg of wood daily in the summer and just over 10 kg in the winter. The descriptive profile suggests that wood acquisition strategies are multi-faceted, with nearly half of the households purchasing some wood, and harvesting undertaken primarily by the household's women.

With regard to predictor variables, household size ranges from 1 to 21 with the average just under seven. There tend to be slightly more women than men as evidenced by the mean sex ratio of 0.81, a logical pattern given the higher incidence male migration, as opposed to female migration, for economic purposes. Many more households are characterized by a young age structure as opposed to an older one. Indeed, members under the age of 15 comprise at least 1/3 of household members in over 2/3 of the study households, while only 10% are characterized by the predominance of members of 50 years of age. Finally, on the SES scale of 1 to 5, 3.19 represents the mean value for households sampled for the Population & Environment survey.

(Table 1 about here)

In order to represent the associations between natural resource use and household characteristics, the multivariate results are presented below. Qualitative insights from the interviews are woven in to

bring depth to presentation of coefficients. Importantly, pseudonyms are used in the presentation that follows.

Results

Our first research question sets the stage for examination of mortality impacts by initially exploring other household factors as associated with fuel wood use. Here we draw upon the literature reviewed above to consider particular arenas of potential impact: selection of resources to be used, decisions with regard to uses for resources as well as strategies with regard to collection and/or purchase. We also examine general level of fuel wood consumption.

(Table 2 about here)

Natural resource selection strategies include those household decisions involving what natural resource is to be used for a given purpose. The results of the multivariate regression analysis (see Table 2) suggest that in rural South Africa, household composition and socioeconomic status have few significant effects on the selection of fuel wood for energy purposes or electricity, a fairly common alternative for cooking and lighting. Regarding electricity as an alternative, this energy source is less often used by larger households, a plausible estimate given that larger households have more individuals for which to provide and more hands available for wood collection.

Qualitative evidence from the interviews substantiates the fact that fuel wood is nearly universally used by households of this region. In addition, the dialogues clearly reveal that, although electricity may be the preferred energy source, its cost is simply prohibitive. As such, within the interviews, the residents themselves articulate the important link between poverty and the fiscal inaccessibility of alternatives to fuel wood. As an example, although the harvesting of live trees is prohibited by local rule, Asnath explains that *"dry wood are scarce and some people use electricity*

stoves but some don't, then they are forced to cut down living trees …." She specifically argues that *"if jobs can be made available we can buy our own electricity stoves and we can stop getting to the bush to collect fuelwood."* Melias verifies this by saying *"electricity is so expensive hence we chop down living trees despite restrictions."* A similar opinion is expressed by Linneth whose mother walks *"far away,"* spending 2-3 hours daily, to collect fuelwood. Linneth further explains that they have no choice but *"if we can have employment opportunities we can buy some electricity."*

Table 2 also reveals that SES and village context make a difference in the use of electricity for cooking and/or lighting. Cursory exploration of specific village locations as related to electricity use does, in fact, suggest that households located in villages with relatively fewer proximate fuel wood resources are more likely to make use of electricity as an alternative energy form. This association is the subject of ongoing analyses. The qualitative interview data also suggest that some households manage to make use of electricity. As an example, consider Mkhela's discussion of resource selection strategies in her household which uses some electricity for cooking and heating water. Her family lives in a village characterized by little local fuelwood, although their SES is relatively high since several members of her household are employed, one as a teacher, one as a nurse. Still,*"other [household members] have completed their [schooling] but unemployment is high so they don't have options but to help at home."* She explains that *"electricity makes things easier,"* since *"we used to collect fuelwood during the time we were little girls, but now it's difficult to find."* Even so, Mkhela's family sometimes purchases wood for cooking *"when we have parties …because you can't use electricity to cook many things."* Clearly Mkhela's household is engaged in tradeoffs with regard to resource selection and time allocation, with SES and village resource context shaping the decision-making process.

In general however, the surveys and interviews suggest that there is little variation in type of energy used, with nearly all households making use of fuelwood as the primary source. The principal factors shaping the use of alternatives are village context and socio-economic status, with income often allowing for the purchase of electricity. Electricity clearly **does** make life *"easier,"* because even when

income is very limited, as in the case of Mumsy's small monthly contribution from her grandmother, she explains *"I spend it on food and electricity."*

With regard to specific uses of fuelwood, as noted, household characteristics only distinguish, in a statistically significant sense, decisions with regard to heating water. Primarily though, we find a pattern of non-significance in that few of the included household characteristics distinguish household's strategies with regard to energy use. Indeed, the interviews also reveal little variation across households in use of wood. Cooking and heating water are, again, nearly universal uses of fuelwood, while only a handful of households engage in the brewing of traditional beer or heating the home with wood. In one of the few households where wood is used for heating the home, Peggy explains *"now that it is winter, we use more fuelwood because people like warming up themselves by sitting around fire."*

Focusing on the level of fuelwood consumed, sex ratio possesses the ability to significantly distinguish the outcome variables, net of the models' other predictors. Specifically, controlling for household size, age composition, and socio-economic status, households with relatively more men tend to use higher levels of wood in both summer and winter. In addition, households with higher SES tend to use slightly more wood particularly in the summer. The interviews also provide evidence that households are clearly very conservative in their resource utilization as daily homestead fires are carefully tended, burning only the requisite amount of wood. Even so, the survey data curiously reveal a fairly wide variation in level of use, ranging from a minimum of 1 kg daily to over 20 kg daily. Higher SES accounts for some of this variation, with households characterized by more possessions typically using slightly higher levels of fuel wood.

Finally, natural resource collection strategies represent an important dimension of household decision-making in that collection involves decisions regarding who will collect, the collection location, and the associated costs of collection in terms of time, money and/or bartered assets. Here, we predict who in the household collects fuelwood. The results of the regression models suggest that household composition and socioeconomic status each have limited, but statistically significant effects on by whom

fuelwood is acquired. In particular, larger households are more likely to have a male head who harvests wood. As would be expected, female heads are less likely to collect wood in households with relatively more male members. Interestingly, net of the other included household characteristics, household size and SES have no significant effect on household collection strategies.

The interviews shed qualitative light on decisions with regard to fuelwood strategies. Specifically, the in-person dialogues often reveal tradeoffs with regard to time and money. As an example, Virginia offers a description of such tradeoffs whereby her household uses wood *"from the field …. for cooking and for boiling water"* although they also purchase wood on occasion *"because [wood] is not available nearby hence we sometimes buy…."* This is not to say, however, that Virginia's household has disposable income. Rather, when asked the source of the cash used to purchase fuelwood, she contends that *"we get this from relatives."*

However, due to the absence of regular income, some households have no option but to acquire scarce fuelwood through harvesting. As explained by Sbongile *"we get [wood] from the bush next to the mountains … it's not easy to find them and we get them from far and we take a long time."* Her household does not purchase fuelwood since their only source of income is a very small and irregular contribution from her mother's old age pension. This cash is *"used to buy Mealie Meal* (a staple grain) *and other groceries. But because we are many at home, the money becomes too little and she also uses it for the funeral insurance."* Sbongile would like to buy natural resources, as opposed to collecting, as she explains: *"If we had money we were going to purchase fuelwood or hire someone to collect water because sometimes you feel tired but with no option."*

Sbongile and Virginia are not alone. A substantial portion of the interviews revealed the pressure that scarcity brings with regard to acquisition of fuelwood. One respondent, Beatrice, even revealed that she illegally collects fuelwood from the game reserve in which she works. She explains that *"…. I sometimes pick up some small pieces of fuelwood and put them in my bag. But we are not*

given the permission to collect, we steal them … we devise some plans to get them out of the reserve, like putting them in my bag where I put something to eat so they cannot recognize them."

We now move to the bottom of Table 2 to explore our second research question which focuses on the association of adult mortality with the various dimensions of resource use. Recent adult mortality experience is associated with an increased likelihood of a household making use of wood, although the negative coefficient for mortality*SES suggests that this association is lesser for households of higher socio-economic status. The same pattern is demonstrated by the positive coefficients suggesting mortality-impacted households are more likely to use wood for cooking and heating water for bathing, with a lesser association for households of higher SES. In addition, the negative estimates for years since mortality nearly reach statistical significance with $p<0.08$ for prediction of cooking with wood and $p<0.07$ for prediction of heating water with wood. Although not reaching the $p<0.05$ threshold, these estimates suggest that the association between these outcomes and adult mortality experience lessens with the passing of time.

Male heads are clearly more likely to collect wood in mortality-impacted households. In examining the gender of the deceased within households with a male head collecting wood, we find that gender is evenly split. It is possible, then, that male heads are called to collection duty in households in crisis. This is further suggested by the negative coefficient estimate for years since mortality, as the likelihood of male heads harvesting wood declines as time passes.

The interviews also reveal substantive and important impacts of an adult mortality on household coping strategies, but these impacts are nuanced and represented by matters of degree. The dialogues suggest that mortality impacts are manifested by subtle, but important, alterations in task allocation and livelihood strategies, along with changes in related opportunity costs. Illustrative examples are presented in the following paragraphs.

In general, patterns of change in the selection, use, collection and consumption strategies of households experiencing an adult mortality are clearly related to the role of the deceased in the

household economy. If the deceased were a resource collector, for example, but did not engage in income-generating work outside of the household, their resource collection duties were typically taken on by other household members. For example, George's household lost their primary resource collector, George's wife. As he explains, *"she used to collect fuelwood in the bush …. She was responsible for household duties like cleaning and other things."* George now stays with his sister's daughter who *"performs those duties now."* George was laid off from his job several months ago and due to the lost income, they stopped regularly purchasing food although *"sometimes we buy, but most of the time we rely on the garden."* Similarly, both of Hope's parents passed away, each of whom had previously assisted in their household's resource collection. Hope explains that when her mother was alive, *"she used to do"* the cooking but now *"I do it myself."* Hope also collects wood and water and, as she says, *"I have to do a lot of things by myself now."* Because of necessity of taking on these new duties Hope no longer has time to tend the garden. *"I used to have a garden and I could go out to collect water to water my plants …. But I buy now [what I used to grow]."*

Although the shifts in time allocation describe above are clearly important, the most significant changes in the household economy were felt when the deceased had contributed wages. But even with that being said, impacts involving natural resource selection, use, collection and consumption strategies varied greatly. In some cases, the lost income had been used to purchase fuelwood and water, with household members subsequently being forced to collect wood and water on their own. Illustrating shifts due to lost wages, Trezia discusses the impacts on her household following the death of her father. He worked as a gate keeper at a local game reserve and contributed important income to the household. Trezia describes *"there are lot of changes like I did not have to collect fuelwood, and he used to buy groceries, but now I need to do that in my own."* However Trezia has not been successful in her search for employment and the household's income had yet to be replaced at the time of the interview. Another example of the potential impacts of lost wages is seen in the situation following the passing of Lucille's husband. Lucille's husband had been engaged in hard labor *"piece jobs like brick making and digging*

toilet holes." During his time of illness he was cared for by a traditional healer and Lucille took a job as domestic worker. Since Lucille was then less available for household tasks, the children took primary responsibility for resource collection *"because they also needed to do the things I used to do."* Unfortunately, after her husband's death, Lucille became ill and she too was no longer able to work and must now rely completely on her children for maintenance of household tasks and modest contributions of income. Overall, Lucille's story reveals a complex array of task reassignments to manage daily living in the context of illness and uncertainty.

Also revealing of the complex changes in household natural resource selection, use, collection and consumption strategies is the reconfiguration of household tasks following the death of Asnara's sister. Asnara's sister worked as a waitress at a local game reserve and made important financial contributions to their household. Now, the household survives on very low levels of income, with the only regular source being the government disability grant paid to her mother, who is the victim of a stroke. In addition to her disabled mother, Asnara takes care of her two children, her sister's child, and her elderly grandmother. The household makes use of a wide variety of natural resources including reeds for mats, marula nuts for jam, and fruits and vegetables for nutrition. They also collect locusts, although as Asnara explains *"we don't go out to look for them but catch those which are attracted by light in the evening."* The water source is unreliable and *"sometimes we spend 2-3 days without water."* The children in the household collect fuelwood and, as she explains *"it is difficult to get fuelwood because there are no longer trees around."* Asnara is looking for a job and, if she finds one, *"I would reduce the boy's responsibilities since I will buy fuelwood. But with water, they would have to collect."* She would prefer that *"these boys would collect sand for … bricks."*

In all, both the survey and interview results suggest natural resource use strategies and levels of consumption vary little in this context given the near universality of fuelwood use for cooking and high levels of use of electricity for lighting. Although universally used, the **level** of consumption is extremely

low given the difficulties inherent in collecting wood. The survey results suggest that village resource context and household SES are the primary forces shaping household fuel wood strategies.

With regard to mortality, both quantitative and qualitative data reveal that adult mortality experiences are associated on natural resource selection and collection strategies. Specifically, interview data suggest that wages lost due to the death of a adult member further reduce the likelihood that a household will be in a position to afford electricity for cooking. In this case, mortality exacerbates poverty, with poverty being the factor most shaping natural resource use strategies. Regarding natural resource collection, the analyses reveal shifts in time allocation of the remaining household members to cover the collection tasks previously undertaken by the deceased, especially with regard to the participation of the male household head in collection duties.

Discussion

The profile of adult mortality in sub-Saharan Africa has shifted dramatically over the past 10 years due to HIV/AIDS. These global and regional patterns testify to the importance of scientific examinations of the implications of mortality experiences for remaining household members. As is well known, HIV/AIDS disproportionately infects "prime age adults" in their crucial employment and parenting years (DAI 2003; de Waal and Whiteside 2003; Haddad and Gillespie 2001). AIDS mortality, therefore, yields important losses of income, labor, knowledge and care, and while these impacts make HIV/AIDS a devastating shock at the individual and household levels, its implications are also felt throughout the most afflicted societies (Haddad and Gillespie 2001).

Although little explored, the environmental dimensions of HIV/AIDS are centrally important to the sustainability of the livelihoods of many rural households and communities in sub-Saharan Africa. Resources from the local environment are integral to day-to-day survival in many rural African households where biomass is used for cooking and wild fruit, vegetables, and bushmeat are used for sustenance (e.g., Dovie, Witkowski and Shackleton 2003; Holmes 2005; Pattanayak and Sills 2001).

The results of this study clearly document the centrality of natural resources in the livelihoods of the surveyed rural South African households. Illustrating this universality, household size has little association with resource use. The interviews' qualitative data also clearly dependence as all respondents described some degree of reliance on the local natural environment particularly as related to fuelwood, marula (fruit used for jam and beer), wild vegetables (guxe, a local spinach), and grasses and reeds (for roofing and mats) (see also Hunter and Twine 2005; Kirkland, Hunter and Twine 2005). Related, the increasing scarcity of natural resources was noted as being a significant hardship almost as frequently as was dependence upon them. As Joyce explains with regard to their trip to collect fuelwood, *"it takes long like 3 hours because it's very far, we pass 2 streams before we reach there."* Indeed, many respondents describe the increasing distances traveled to find fuelwood. In addition, although traditional tribal authorities have restricted fuelwood collection to fallen wood, many respondents suggested that population pressures and decreasing resource availability have led to increases in the harvesting of live trees. As explained by Josephine, *"Yes, it is forbidden to cut live trees, but because we need them for our day-to-day life, hence the cutting."* Particular revealing of the hardship, even the trees bearing valuable marula nuts have even been targeted for fuel: *"a lot of people depend of fuelwood so the competition is very high and the trees are finished."*

Even with the centrality of resource dependence, both survey and interview data suggest that the loss of an adult household member shapes households' resource strategies. Mortality-impacted households are more likely to use wood in general, as well as use wood specifically for cooking and for heating water. Reflecting the importance of poverty in resource strategies, the positive association between of mortality on wood use is lessened by SES as well as years since death. Of course, the loss of household members responsible for natural resource collection impacts the time allocation of others, particularly if there is insufficient household income to consider purchasing the required resources as a collection strategy. The survey data suggest that male household heads pick up collection duties in the crisis period after an adult mortality experience. The interview data reveal more complexity in that the

responsibilities of the deceased resource collector appear spread across other family members, with children playing an important role in helping to recover from the death of an adult collector. In several households, children spent considerable time collecting natural resources, often at the expense of their studies. Of course there are gender dimensions to the household impacts as well. As related to resource use strategies, inequalities in the household division of labor typically imply that, in the face of resource scarcity, women often spend increasing amounts of time engaged in the use of inefficient and dangerous alternates. Such insights clearly reveal that adult mortality experiences indeed have important impacts on opportunity costs and quality of life for the remaining household members.

Without a doubt, poverty is an integral force in perpetuating the observed dependence on fuelwood, as well as denying alternatives to the hours spent harvesting. As noted, many rural South African households are already living on the margins, and as related to HIV/AIDS, if a household's adult mortality experience means the loss of a wage earner, the impacts are even more dramatic than in the case of the loss of a resource collector. Plunging further into poverty yields impacts particularly on diet, food security, and often brings substitution of collected goods for those previously purchased. These findings correspond with past research demonstrating the importance of natural resources as a "buffer" with regard to households "shocks" such as an HIV/AIDS related mortality experience. Indeed, the vast majority of rural households depend heavily on natural resources as both a buffer against poverty, as well as a means of generating income (Cunningham 1988; Shackleton 1996; Shackleton and Shackleton 2000). Evidence of this relationship is provided by Sukeda who explains that before her husband's death, *"we used to buy groceries like beef and chicken but now we can only afford mixed portions …. so you find that we rely on the field …"*

It is also clear that households that lose adult wage-earners shift time allocation much like those losing resource collectors. Often, however, the tasks are not simply reassigned, but rather, households stop purchasing resources and start collecting alternative natural resources. As stated by Lenia whose wage-earning husband passed away, *"[his death] brought a lot of changes the first thing being changes*

on the diet the second thing is that we are no longer able to buy fuelwood and water, so it requires us to do that by our own hands." Similar impacts are described by Tara. Although in the past Tara's household hired someone to collect fuelwood for them, since her husband's death she describes *"we depend more now in the field."* … he worked at Kruger National Park …. and she says, *"yes, there are definitely changes."*

Analyses of the effect of adult mortality on household natural resource strategies yield policy implications in several arenas. With regard to natural resource conservation policy, unfortunately, ecological research suggests that environmental degradation in rural South Africa continues (e.g. Twine et al. 2003). Although local populations depend greatly on indigenous natural resources, these resources are coming under increasing pressure due to poverty, as evidenced here, high human population densities, as well as the weakening of the traditional tribal authority structures historically responsible for access and control (Twine et al. 2003). In addition, extraction rates appear unsustainable (Banks et al. 1996). As such, the increasing risk of adult mortality due to HIV/AIDS adds insult to injury when it comes to marginal households dealing with decline in the local stock of natural resources essential for day-to-day needs. Natural resource conservation policy is desperately needed to enhance local stewardship, while more specific interventions might encourage the establishment of communal fuelwood plots and wild indigenous products for meeting dietary needs. It is suggested that past energy policy has also not helped and, as such, this is another arena of possible progress. In South Africa, for example, energy planning has been concentrated on urban areas and in commercial fuels for industry, leaving many historically black "homelands" (such as the study site presented here) characterized by a continued dependence upon biomass energy (Griffin et al. 1993).

Finally, public health is another arena of policy import. Although HIV/AIDS is an obvious public health priority, from an environmental perspective, some scholars suggest that the increasing financial and time costs of household dependence on declining stocks of locally available natural resources may also have health consequences. Specifically in regions where little wood is available, it is

argued that those unable to afford alternate forms of energy will be forced to reduce their requirements possibly such that heating food or boiling water "become luxuries." (Griffin et al. 1993:72) Such association further testifies to the importance of focusing on the environmental dimensions of HIV/AIDS since households turn increasingly to local stocks in the face of declining alternatives.

In closing, we must revisit an important limitation of these analyses. The methodology used within this project did not allow for identification *a priori* households experiencing only HIV/AIDS mortality. Rather, our focus has been on households experiencing the loss of an adult household member in the prime working years with past scholarship suggesting that nearly half of these mortality experiences are likely due to HIV/AIDS. The lack of integration of environmental dimensions within AIDS scholarship necessitates these broad analyses as a first step, with our ongoing efforts designed to distinguish specifically across causes of death to reveal a more nuanced story with regard to the environmental dimensions of AIDS. That said, this exploration began with mention of two important trends related to population and the environment: HIV/AIDS and environmental degradation in rural sub-Saharan Africa. The evidence from these analyses suggests these adult mortality and environmental scarcity are indeed colliding to shape and re-shape household strategies with regard to natural resource use and collection strategies. Importantly, the survey data reveal associations between SES and village resource context reflecting the interaction between poverty and location in determining household coping strategies. Combined with the interview data, the results reveal subtle and complex shifts at the household level. Based on this work, we argue that better understanding the role of natural resources in coping strategies is central to the design of effective policy aimed at supporting impoverished, adult mortality-impacted rural households.

References:

Banks B I, Griffin N, Shackelton C M, Shackelton S E, and J Mavrandonis, 1996. "Wood supply and demand around two rural settlements in a semi-arid savanna, South Africa." *Biomass and Bioenergy*, 11: 319-331.

Barany, M., A.L. Hammett, A. Sene, A. and B. Amichev. 2001. "Non-timber forest benefits and HIV/AIDS in sub-Saharan Africa." *Journal of Forestry.* 99 :36-42.

Dasgupta, Partha. 1995. "Population, Poverty, and the Local Environment," S*cientific American.* pp. 40-45.

Day, C. and A. Gray. 2003. "Health and Related Indicators." Chapter 21 (pp. 411-531) in Ijumba, P. (Ed.) *South African Health Review 2002.* Health Systems Trust: Durban, South Africa.

DeWaal, A. and A. Whiteside. 2003. "New variant famine: AIDS and food crisis in southern Africa." *The Lancet.* Dec. 6, 362, 9399:1938-9.

Dovie, Delali BK, ETF Witkowski, and Charlie M. Shackleton. 2003. "Direct use value of smallholder crop production in a semi arid South African village." *Agricultural Systems.* 76: 337-357.

Ilahi, Nadeem and Franque Grimard. 2000. "Public Infrastructure and Private Costs: Water Supply and Time Allocation of Women in Rural Pakistan." *Economic Development and Cultural Change.* 49, 1: 45-75.

Griffen NJ, Banks D I, Mavrandonis J, Shackleton C M, and S E Shackelton, 1993. "Fuel use in six rural settlements in Gazankulu." *Journal of Energy in Southern Africa.*

Haddad, L. and S. Gillespie. 2001. "Effective Food and Nutrition Policy Responses to HIV/AIDS What We Know and What We Need to Know." *Journal of International Development.* 13, 4:487-511.

Hargreaves JR, Pronyk PM. (2003). HIV/AIDS and rural development: realities, relationships and responses. In: Greenburg, S.(ed) *Development Update: Complexities, lost opportunities and prospects – rural development in South Africa,* 4(1). Interfund: pp 85-112.

Holmes, C. 2005. "Cultural Variation, Decision Making and Local Institutions: An Examination of Fuelwood Use in Western Tanzania." *Society and Natural Resources.* 18: 61-73.

Hunter, LM and W Twine 2005. "Adult Mortality and Household Dietary Use of the Local Environment: Qualitative Evidence from the Agincourt Field Site in Rural South Africa." Institute of Behavioral Science Research Program on Environment and Behavior Working Paper Series. EB2005,001. http://www.colorado.edu/ibs/pubs/eb/eb2005-0001.pdf

Johnson, S., G. Schlerhout, M. Steinberg, B. Russell, K. Hall and J. Morgan. 2003. "AIDS in the Household." Chapter 11 (pp. 203-216) in Ijumba, P. (Ed.) *South African Health Review 2002.* Health Systems Trust: Durban, South Africa.

Kirkland, T., LM Hunter, W Twine. 2005. "'The Bush is No More:' Insights on Natural Resource Availability from the Agincourt Field Site in Rural South Africa." Institute of Behavioral Science Research Program on Environment and Behavior Working Paper Series. EB2005,002. http://www.colorado.edu/ibs/pubs/eb/eb2005-0002.pdf

Koziell, I. and Saunders, J. (eds.) 2001. *Living off Biodiversity: Exploring Livelihoods and Biodiversity*. IIED, London.

Letsela T, Edward T F, Witkowski, and K. Balkwill, 2002. "Direct use values of communal resources in Bokong and Tsehlanyane in Lesotho: whither the commons?" *Int. J. Sustain. Dev. World Ecol.* 9: 351-368.

Qureshi, M.H. and Kumar, S. 1998. Contributions of common lands to household economies in Haryana, India. *Environmental Conservation.* 25: 342-353.

Pattanayak, S.K. and E.O. Sills. 2001. "Do Tropical Forests Provide Natural Insurance? The Microeconomics of Non Timber Forest Product Collection in the Brazilian Amazon." *Land Economics.* 77: 595-612.

Rugalema, G. and V. Khanye. 2002. "African Rural Development in the Face of HIV/AIDS." *Agriculture and Rural Development.* 2, 9:7-14.

Shackleton, C.M. 1996. "Potential Stimulation of Local Rural Economies by Harvesting Secondary Products: A Case Study of the Central Eastern Transvaal lowveld, South Africa." *Ambio*. 25: 33-38.

Shackleton, C.M., S.E. Shackleton and B. Cousins. 2001. "The Role of Land-based Strategies in Rural Livelihoods: The Contribution of Arable Production, Animal Husbandry and Natural Resource Harvesting in Communal Areas in South Africa." *Development Southern Africa.* 18: 581-604.

Shackleton, C.M. and Shackleton, S.E 2000. Direct use values of savanna resources harvested from communal savannas in the Bushbuckridge lowveld, South Africa. *Journal of Tropical Forest Products*, 6(1): 28-47.

Shackleton, C.M. and Shackleton, S. 2004. The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. *South African Journal of Science*, 100:658-664.

Stiles, D. 1994. Tribals and trade: a strategy for cultural and ecological survival. *Ambio*, 23:106-111.

The Energy and Research Institute (TERI). 1994. "Micro level coping strategies by rural women for managing biomass resources." Project Report No. 1994RE53. Retrieved 2003 http://www.teriin.org/reports/rep31/rep31.htm

Twine, W., D. Moshe, T. Netshiluvhi and M. Siphugu. 2003. "Consumption and Direct-use Values of Savanna Bio-resources Used by Rural Households in Mametja, a Semi-arid Area of Limpopo province, South Africa". *South African Journal of Science*. 99: 467-473.

UNAIDS. 2004a. *2004 Global Report on the AIDS Epidemic: 4th Global Report.* Geneva, Switzerland. Online: http://www.unaids.org/bangkok2004/report_pdf.html (downloaded July, 2004).

----------. 2004b. “AIDS Epidemic in Sub-Saharan Africa.” Fact Sheet. Geneva, Switzerland. Online: http://www.unaids.org/bangkok2004/factsheets.html (downloaded July, 2004).

Vogel, U. 2002. “Why is Combating AIDS So Difficult? ” *Agriculture and Rural Development.* 2 :3-5.

Figure 1: Study Area, Agincourt Health and Population Unit, Limpopo Province, South Africa

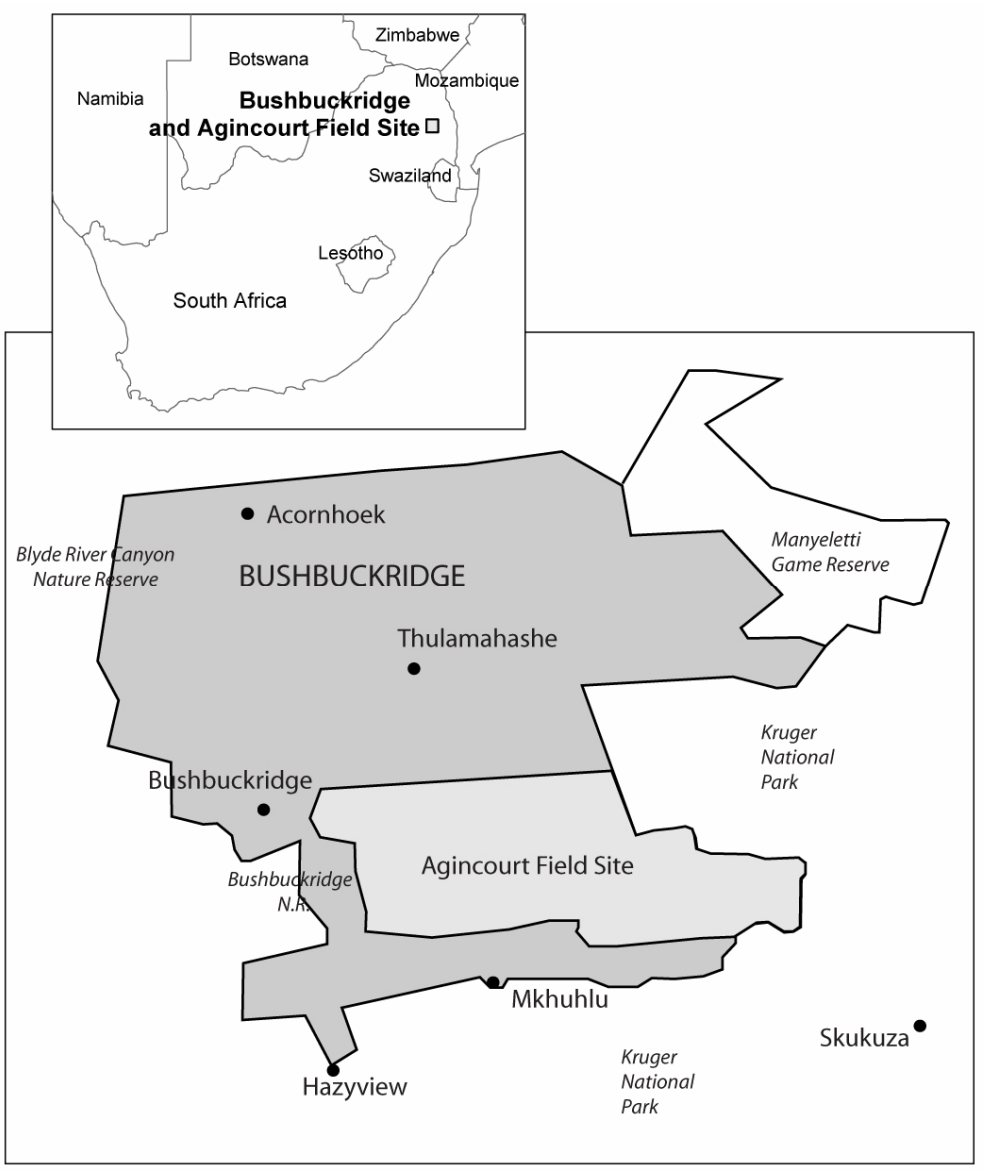

Table 1: Descriptive Profiles of Incorporated Variables, Study Households, Agincourt Health and Population Unit, Limpopo Province, South Africa

Resource Use	*Percentage or Mean*	*Min*	*Max*	*N*
Use wood for fuel (%)	92.8%			241
Wood uses				
Cooking	90.8%			227
Heating water for bathing	85.4%			225
Heating house	1.3%			227
Brewing traditional beer	3.3%			227
Alternative Fuels				
Electricity for cooking	31.3%			241
Electricity for lighting	82.5%			241
Level of use				
Wood per day in summer (in kg)	8.70	0	22	171
Wood per day in winter (in kg)	10.38	0	29	171
Acquisition Strategies				
Purchases wood	44.6%			241
Male head harvests	13.8%			241
Female head or wife harvests	36.2%			241
Son harvests	7.9%			241
Daughter harvests	34.6%			241
Other female harvests	14.1%			241
	22.0%			
Household Characteristics				
Household size	7.71	1	21	241
Composition				
Sex ratio (male:female)	0.81	0	4	241
Young age structure	70.50%			241
Older age structure	9.53%			241
SES				
Possessions Index	3.19	1	5	239

Table 2: Multivariate Estimation of Household Fuelwood Strategies by Household Characteristics, Agincourt Health and Population Unit, Limpopo Province, South Africa

	Use Wood	Alternative Energy		Uses of Wood		Level of Use			Acquisition Strategies			
	yes/no	Electricity for cooking	Electricity for lighting	Cooking	Heating water	Wood per day (kg, summer)	Wood per day (kg, winter)	Buy wood	Male head harvests	Female head, wife harvests	Son harvests	Daughter harvests
Research Question #1: What are the associations between household size, composition and economic status, and natural resource use?												
Household Size	-0.01	**-0.10 ***	0.03	0.03	0.09	0.04	0.10	-0.01	**0.18** **	-0.03	-0.08	0.03
Household Composition												
Sex Ratio	-0.41	0.20	0.07	-0.33	-0.49	**1.92** **	**1.93** **	0.10	0.35	**-0.42** *	0.07	0.07
Young Age Structure	-0.67	0.20	-0.70	-0.63	-0.34	0.48	-1.80	-0.22	-0.51	-0.26	-0.55	0.07
Older Age Structure	0.15	-1.27	-0.70	0.50	1.38	2.64 *	3.67	0.06	0.89	0.25	-0.99	0.18
SES												
Possessions Index	0.50	0.11	0.19	0.33	**0.14** **	**0.99** *	0.61	-0.06	0.18	-0.10	-0.05	-0.12
Village	-0.04	**-0.06 ***	**-0.25** **	-0.04	-0.09	-0.01	-0.02	-0.01	-0.01	-0.01	0.02	-0.07
Research Question #2: Beyond these household characteristics, how is mortality experience associated with natural resources?												
Adult Mortality within past 2 years	**3.39** *	-1.27	0.28	**3.48** **	**3.02** **	3.47	-0.17	0.01	**2.84** *	-0.54	-1.89	1.20
Mortality*SES	**-0.83** *	0.09	-0.19	**-0.69** *	**-0.64** **	-1.21	0.61	0.05	-0.36	-0.05	0.64	-0.30
Years since mortality	-0.40	0.36	0.13	-0.56	-0.49	0.13	0.61	-0.14	**-0.89** **	0.23	-0.59	-0.05
Constant	**2.32** *	-0.09	3.68	**2.15** *	**2.19** **	4.12	9.05	0.19	**-3.79** **	0.64	-1.27	-0.17
R^2	0.08	0.06	0.20	0.08	0.10	0.11	0.09	0.01	0.11	0.04	0.08	0.04
N	239	239	239	239	239	169	169	239	239	239	239	239

*p<0.05;**p<0.01

1: Data Source: Agincourt Health and Population Unit, Population & Environment Survey, June 2004.