

Population Dynamics and the Environment:

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

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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 fuelwood strategies, as shaped by households' mortality experience. In the year 2000, 21.5% of deaths in the study region of South Africa's Limpopo 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 does mortality shape 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, although the quantitative analyses reveal little distinction between fuelwood strategies between mortality-impacted households and their non-mortality counterparts, the interviews provide insight into the 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.

Keywords: Fuelwood, HIV/AIDS, Mortality, Natural Resources, Rural Livelihoods, South Africa

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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 fuelwood, 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 does an adult mortality experience shape 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., fuelwood, 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 / €80) 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. fuelwood, 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 fuelwood 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. 1992; 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 fuelwood despite its low sustained heat, fast burn rate, and excessive smoke due to “extreme difficulties” obtaining the preferred species of fuelwood (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

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

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 are reshaped by the death of an adult household member. Grounded in the above literature we explore two 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 does an adult mortality experience shape the ways in which households select, use, collect and consume key natural resources?*

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 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 fuelwood, 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 fuelwood 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

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.

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 (in kg), and acquisition strategies (purchase, harvested by specific household members). In the analyses that follow, all outcome variables, except amount of fuelwood 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 predictor 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).

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 fuelwood, 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. Even with the high level of dependence on fuelwood, it is clear that most households are electrified as over half 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 about 9 kg of wood daily in the summer and 10.5 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 29 with the average just under eight. 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 half of the study households, while only 9% 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 fuelwood use. We ask: *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? 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 fuelwood 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 fuelwood for energy purposes or electricity, a fairly common alternative for cooking and lighting. With the only significant association, households with a young age structure are less likely to use wood generally, perhaps resultant of lower levels of prime age labor for collection activities. Regarding electricity as an alternative, this energy source is less often used by households with older age structures, and more often used by households with higher socio-economic standing as measured through the possession index. Both associations are plausible given that older households are most likely to have consistent human presence for tending wood fires throughout the day, while households characterized by greater possessions may have more fiscal resources to put toward the purchase of electricity as fuel.

The interviews substantiate the fact that fuelwood is nearly universally used by residents of this region. The dialogues clearly reveal that, although electricity may be the preferred energy source, its cost is simply prohibitive. Indeed, the respondents often make an association between poverty and the fiscal inaccessibility of electricity. 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. And sometimes you buy when you have money but [you may still be] purchasing chopped living fuelwood.”* 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.*”

Some households do, however, manage to make use of electricity. The interview with Mkhela revealed the selection strategies in her household which mainly uses electricity for cooking and heating water. Several members of her household are employed, one as a teacher, one as a nurse, although “*others 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.*” Still, Mkhela’s family sometimes purchases wood for cooking “*when we have parties ...because you can’t use electricity to cook many things.*”

In general, 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 factor shaping the use of alternatives is 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, household characteristics only distinguish, in a statistically significant sense, decisions with regard to heating water for bathing purposes. Larger households are more likely to make use of wood for this purpose, while households with higher SES and those in which men predominate are less likely to use wood to heat water for bathing, net of the models’ other predictors. Again, these households may opt to purchase electricity as an alternative energy source for these purposes. Interestingly, the included independent variables were unable to differentially predict other wood uses such as cooking, heating the home, or brewing traditional beer. The non-significance of these associations is qualitatively reflected in the interviews in that very little evidence arises to suggest that wood is used differently across households. 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 heat, 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, only age structure possesses the ability to significantly distinguish the outcome variables, net of the models' other predictors. Specifically, controlling for household size, sex ratio, and socio-economic status, households with greater proportions of elderly individuals tend to use higher levels of wood in both summer and winter. Again, it is possible that this is due to the increased likelihood of a constant human presence for tending the homestead flame, or perhaps greater necessity for homestead heating to comfort elderly residents, although our data do not allow verification of either explanation. The interviews, also, reveal little explanation as to level of wood use in that study households are clearly very conservative in their resource utilization. Daily homestead fires are carefully tended, burning only the requisite amount of wood for the task at hand.

Even so, the survey data curiously reveal a fairly wide variation in level of use, ranging from a minimum of 1 kg daily to 34 kg daily. Deeper exploration revealed that, as opposed to predictably varying by household socio-economic or demographic characteristics, level of daily use has a greater association with village location, although such contextual factors are not central to the analyses here. Specifically, the inclusion of dummy variables for each village (minus a reference category) in the multivariate regression models increased the proportion variance explained from 0.03 (summer) and 0.05 (winter) to 0.29 (summer) and 0.24 (winter). As such, these contextual influences represent important arenas for further research.

Finally, natural resource collection strategies represent an important dimension of household strategies 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. The results of the regression models suggest that household composition and socioeconomic status each have limited, but statistically significant effects on where and by whom fuelwood is acquired. In particular, households with a young age structure are less likely to purchase wood. On the other hand, the effects of a household's sex ratio and socioeconomic status are seen in terms of who performs the task of harvesting wood. Results suggest that, households with proportionally more men are more likely to have the male head harvesting wood, while the likelihood of the female household head

harvesting wood decreases at a similar magnitude. In wealthier households, daughters are less likely to harvest wood than in poorer households, perhaps due to the fact that the daughters may be engaged in wage labor thereby contributing to SES but less available for resource collection. Interestingly, net of the other included household characteristics, household size has no significant effect on any aspect of household natural resource 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, Betrice, 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.”*

Moving to the impact of adult mortality, the second research question asks: *Beyond the household characteristics of size, composition and SES, how does an adult mortality experience shape the ways in which households select, use, collect and consume key natural resources?* In a nutshell, the survey results reveal little association. Table 2 presents the coefficients that distinguish those households having experienced an adult mortality in the 2 years prior to the survey from those that had not, with all other predictors remaining in the models. The other predictors' coefficients change little, and as such, are not shown.

Specifically, recent adult mortality experience has no significant predictive ability, beyond household size, composition, and SES, with regard to the use of fuelwood vis-à-vis electricity, the specific uses of fuelwood, level of fuelwood consumed, or decisions regarding the purchase of fuelwood. The only significant association appears with regard to collection strategies, whereby mortality-impacted households are less likely to have a son collecting fuelwood. Indeed, in these cases, it is possible that this association is precisely due to the loss of this younger male household member.

The interview results suggest, however, serious limitations to the representation of mortality experience through a single coefficient in multivariate regression models. Indeed, the interviews 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, the interviews 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 interviews do, however, reveal that adult mortality experiences do have effects on natural resource selection and collection strategies. Specifically, 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 interviews clearly revealed shifts in time allocation of the remaining household members to cover the collection tasks previously undertaken by the deceased.

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.

The results of this study clearly document the centrality of natural resources in the livelihoods of the surveyed rural South African households. Within the interviews, nearly all respondents described some degree of dependence 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.”*

Clearly, the loss of an adult household member responsible for natural resource collection impacts the time allocation of other household members, particularly if there is insufficient household income to consider purchasing the required resources as a collection strategy. Typically, the responsibilities of the deceased resource collector are spread across other family members, and often children play 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 & 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."*

Importantly, although the interview dialogues reveal important shifts in task allocation and resource dependence, the survey results presented above suggest little statistical association between household size, composition, economic status, adult mortality, and natural resource selection, use, collection and consumption strategies. Further, the proportion variance explained in the explored dimensions of resource use are slight as evidenced by the low R^2 values, with the inclusion of an adult mortality indicator making little difference in the model's ability to explain changes in natural resource selection, use, collection and consumption strategies. We argue that shifts in household resource strategies are subtle and complex at the household level, although the interviews suggest that they represent important household changes in time and fiscal allocations.

Analyses of the effect of adult mortality on household natural resource strategies yields 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, 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 trends are indeed colliding to shape and re-shape household strategies with regard to natural resource use and collection strategies. 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, AIDS-impacted rural households.

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

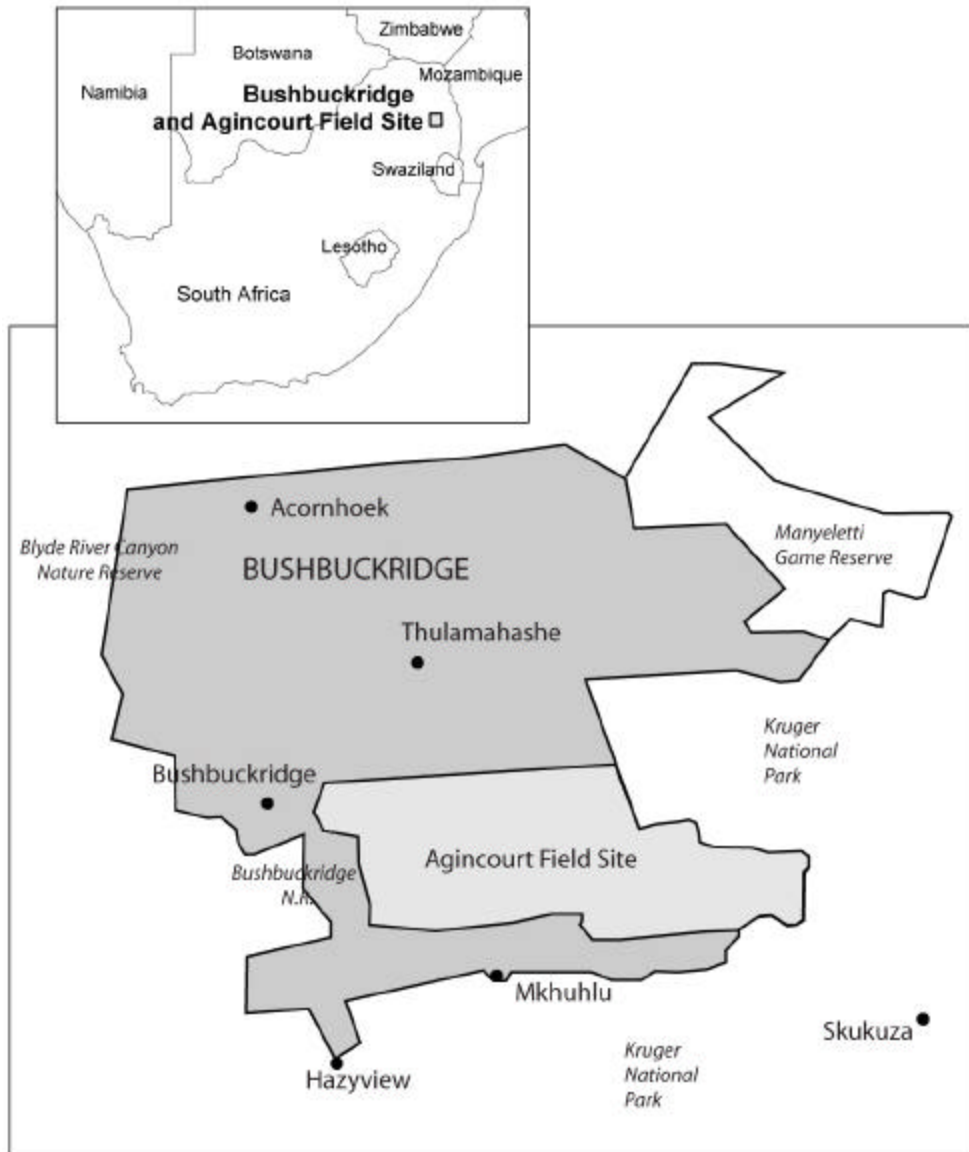


Table 1: Descriptive Profiles of Incorporated Variables, Study Households, Agincourt Health and Population Unit, Limpopo Province, South Africa

<i>Resource Use</i>	<i>Percentage or Mean</i>	<i>Min</i>	<i>Max</i>	<i>N</i>
Use wood for fuel (%)	92.3%			246
Wood uses				
Cooking	98.7%			227
Heating water for bathing	93.8%			225
Heating home	1.3%			227
Brew traditional beer	3.3%			243
Alternative Fuels				
Electricity for cooking	31.3%			246
Electricity for lighting	51.6%			246
Level of use				
Wood per day in summer (in kg)	9.02	0	34	176
Wood per day in winter (in kg)	10.54	0	34	175
Acquisition Strategies				
Purchases wood	45.5%			246
Male head harvests	13.4%			246
Female head or wife harvests	36.2%			246
Son harvests	7.7%			246
Daughter harvests	34.2%			246
Household Characteristics				
Household size	7.71	1	29	246
Composition				
Sex ratio (male:female)	0.81	0	4	246
Young age structure	58.54%			
Older age structure	8.94%			246
SES				
Possessions Index	3.19	1	5	244

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

	<u>Use Wood</u>	<u>Alternative Fuels</u>		<u>Uses of Wood</u>				<u>Level of Use</u>		<u>Acquisition Strategies</u>				
	yes/no	Electricity for cooking	Electricity for lighting	Cooking	Heating water	Heating house	Brew beer	Wood per day (kg, summer)	Wood per day (kg, winter)	Buy wood	Male head harvests	Female head, wife harvests	Son harvests	Daughter harvests
Household Size	-0.26	-0.13	-0.01	1.36	0.68 *	0.17	0.05	0.13	0.24	0.10	0.28	-0.09	-0.25	-0.05
Household Composition														
Sex Ratio	-0.41	0.14	-0.07	0.00	-0.49 *	-0.30	-0.21	0.51	0.64	0.06	0.42 *	-0.38 *	0.05	0.13
Young Age Structure	-1.18 **	-0.36	0.09	-0.66	0.22	0.48	0.86	0.34	-0.24	-0.51 *	0.40	-0.35	-0.52	0.34
Older Age Structure ²	0.03	-1.21 *	0.32	--	--	1.70	1.34	2.08 *	3.90 **	0.02	0.95	0.31	-0.83	0.19
SES														
Possessions Index	0.17	0.18 *	0.07	-0.46	-0.54 **	-0.29	-0.08	0.21	0.08	-0.05	0.10	-0.15	0.12	-0.19 *
Constant	3.90 ***	-0.81 *	-0.17	2.67	2.97 **	-4.36 *	-3.91 **	7.19 ***	8.88	-0.05	-3.76 ***	0.61	-1.87 *	-0.27
R ²	0.06	0.02	0.00	0.92	0.08	0.07	0.05	0.03	0.05	0.01	0.04	0.04	0.02	0.02
N	244	244	244	204	202	225	241	174	173	244	244	244	244	244
<i>Separate Models with mortality experience added as predictor:³</i>														
Adult Mortality within past 2 years	-0.07	-0.05	-0.06	0.48	-0.30	0.44	1.05	0.35	-0.17	-0.25	-0.07	-0.30	-0.66	0.23
R ²	0.06	0.03	0.00	0.11	0.09	0.07	0.07	0.03	0.05	0.02	0.04	0.04	0.03	0.02

*p<0.1;**p<0.05;***p<0.01

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

2: In some models, this predictor dropped due to collinearity.

3: Coefficients for household characteristics in mortality models not presented (available from lead author).