Welfare and Environment in Rural Uganda

Panel analysis with small-area estimation techniques

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Abstract

This report uses a relatively new method called 'small area estimation' to analyze the relationship between poverty and the environment in Uganda for regions, districts, counties and sub-counties of Uganda. The method was applied by combining spatially disaggregated poverty and bio-physical data for 1991 and for 1999/2000.

The results indicate that poverty is less is in areas that have been degraded, subsistence farm wetlands (reclaimed) and highest in areas with mainly grasslands or woodlands. Poverty has declined overall in most counties and sub counties in Uganda with an exception of some areas in Northern Uganda. On the other hand, environmental degradation is more visible in areas of eastern, central and western Uganda. Agro-climatic variables and roads are related to rural poverty in different ways and magnitudes depending on the stratum. The accuracy of these results is reasonable for regional upto the county level. Comparing these results with those of poverty without biomass, we find fairly high correlations. Such a combination of information is valuable to policy makers who continue to struggle with the twin objectives of alleviating poverty in the short run and preserving the natural resource base in the long run.

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1. Introduction

In most countries poverty and environmental degradation are spatially concentrated. Poverty in remote inaccessible areas with unfavourable natural conditions can often be found in the same country as relative affluence in more favourable locations close to major cities and markets. Information on the spatial distribution of poverty and environmental degradation is of interest to policy makers and researchers for a number of reasons: Firstly it can be used to quantify disparities in welfare across regions or districts and identify the areas that are falling behind the process of economic development and environmental conservation; Secondly, it facilitates the targeting of programs whose purpose is, at least in part, to alleviate poverty such as environmental conservation, education, credit, health, and food aid; Thirdly, it may shed light on the geographic factors associated with poverty, such as degraded forest areas and reclaimed wetlands.

Environmental degradation can inflict serious damage on poor people, because their livelihoods often depend on natural resource use, and their living conditions offer little protection from the degraded environment. Environmental quality is a very important determinant of their health, security, energy supplies, and housing quality (Dasgupta *et al.*, 2003). Studies have shown that the poor peoples' economic dependence on natural resources makes them particularly vulnerable to environmental degradation (Cavendish, 1999; Cavendish, 2000; Kepe, 1999). Combining the panel poverty estimates with national panel biophysical data enables us to explore the contemporaneous correlation between changes in poverty (welfare) and natural resource degradation at a level of geographic detail that has not been feasible previously.

This study attempts to explore the following questions:

1. How have poverty and the natural environment changed between 1991 and 1999/2000?
2. What role do initial environmental conditions play in poverty reduction?

Okwi *et al.* (2005) have shown that the inclusion of biophysical information significantly helps to improve the poverty estimates and also enables targeting of poverty reduction programmes at the sub county level. However, information about the relationship between changes in poverty and land use has not been available and none of the research questions formulated above has been addressed. Therefore, we apply the panel analysis of small-area estimation techniques for rural Uganda suggested by Hoogeveen *et al.* (2004) in which we incorporate bio-physical information as suggested in Okwi *et al.* (2005). In combination with the results of Okwi *et al.* (2005), we set up a panel database of poverty indicators and land use covers for rural Uganda in 1991 and 1999.

The presence of panel poverty maps for rural areas and panel biomass maps opens up opportunities for analysing the poverty-environment nexus in rural Uganda. For instance, those maps allow us to consider changes in poverty and to relate these changes to changes in (environmental) initial conditions. As such, the main objective of this study is

to compare changes in poverty indicators with land use changes[1] and to assess the direction of change. Specifically, we explore how changes in poverty and changes in environmental variables are correlated, and how initial conditions affect changes in poverty and environmental degradation.

The combined information will also prove valuable for scientific analysis. Until now, research on poverty and the environment is either based on case study approaches or on cross-country studies. The former is unrepresentative; the latter is clouded with data incomparability problems (see Atkinson and Brandolini (1999) on the problems associated to use of the Deininger and Squire data set). By providing comparable information for many data points, the proposed study solves these problems. The use of a spatial data base also allows us to go beyond correlations and to investigate trends in the relations between poverty and the environment.

The report is organized as follows. Section 2 summarizes the data and methodology on the estimation of poverty indicators for rural Uganda in 1999. Section 3 presents the first stage and the second stage regressions, and it discusses the results. Maps relating to this section are presented in the appendices. The last section concludes and presents implications for policy makers.

2. Poverty mapping for rural Uganda 1999

2.1 Data

For the estimation of the poverty indicators for rural Uganda 1999, we use three different household data sets: census data for 1991 and Integrated Household Survey (HIS) from 1992 and 1999/2000 (UNHS). The IHS used a stratified sample of 10,000 households in both rural and urban areas. The survey questionnaire collected information on household and demographic characteristics, education, assets, employment, income and expenditure (UBOS, 1992/93). This survey was based on four regions divided into rural and urban strata. In this study, we only use 1058 rural households present in both the IHS and the UNHS for the 4 rural strata, so that we derive updated welfare estimates for 1999.

The 1991 Population and Housing Census was conducted by the same institution (UBOS) and was meant to cover the entire population in both rural and urban areas. Two forms of questionnaires were used, a short form and a long form. The short form of the questionnaire mainly covered information on household members and education and was administered to all households in the country. The long form of the questionnaire covered housing characteristics and access to basic utilities and was administered to only 10% of rural areas (UBOS, 1991). The 10% is representative at district level. Although the census did not collect information on income and expenditure, it provides information on a number of characteristics likely to be correlates of poverty. The census and

[1] Land use change refers to any increase or decrease in the proportion of land area under any type of land use. This land may be converted to any other type of land use e.g. wetlands being reclaimed for subsistence farming or urban areas growing to reclaim some subsistence farm areas.

survey data have several common household variables such as household size composition, education, housing characteristics, access to utilities and location of residences.

The bio-physical information is derived from the National Biomass Study (NBS)[2] organized by the Ministry of Water, Lands and the Environment. NBS collected geo-referenced information on a variety of spatially referenced variables describing topography, land cover and land use and roads for 1991 and 2000. The project developed its own classification system based on a combination of land covers and land uses. This information covers changes in land cover such as broadleaved tree plantation or woodlots, coniferous plantations, tropical high forests (normal and depleted/encroached), woodland, grassland, wetlands, water resources and land use such as subsistence and commercial farmland, and changes in landscape among other aspects. In the NBS project, the country was split into 9000 plots with 3 sample plots at each intersection. However, due to influences of population density and agro ecological zones on land cover and tree growth, some adjustments were made on the overall total sample plots. Topographic maps, land cover maps (1:50,000) and Global Positioning System (GPS) were used to locate the field plots on the ground. There were four categories of data capture and processing i.e. mapping (spatial and its attributes), biomass survey (filed plot measurements), monitoring of biomass and land cover change. This information details the woody biomass stock for each plot and it can be used to assess the relationship between tree cover and poverty. The data is extremely rich in bio-physical factors and also includes the distribution of infrastructure like markets, roads, schools and others. Besides, the GIS format of the data allows us to explore the possibilities of merging the data sets using GIS variables. Many of these variables required considerable cleaning, processing, and further transformation in order to generate the variables used in the spatial analysis.

Table 1. The distribution of land cover and land use.

Stratum	**Area(Ha)**	**Percentage**
Plantations Hardwoods – deciduous trees/broadleaves (hardwood)	18,682	0
Plantations Softwoods- coniferous trees	16,384	0
Tropical high forest (THF)- Normally stocked	650,150	3
Tropical high forest (THF) – Degraded/depleted	274,058	1
Woodlands – trees and shrubs (average height > 4m)	3,974,102	16
Bush lands - bush, thickets, scrub (average height < 4m)	1,422,395	6
Grasslands –rangelands, pastureland, open savannah including scattered	5,115,266	21
Wetlands – wetland vegetation; swamp areas, papyrus and other sedges	484,037	2
Subsistence Farmlands –mixed farmland, smallholdings in use or recently	8,400,999	35
Commercial Farmlands – mono cropped, non seasonal farmland usually	68,446	0
Built up areas – urban or rural build up areas	36,571	0
Water – Lakes, rivers and ponds	3,690,254	15
Impediments – bare rocks and soils	3,713	0
Total	**24,155,058**	**100**

Source: National Biomass Study (2002), Uganda.

[2] See Forest Department (2002 for details about the data

2.2 Using small area welfare methods to estimate poverty indicators

In Uganda, the availability of high-resolution data sets a strong foundation for us to produce and use poverty-biomass maps. Although several approaches have been developed to design poverty maps, there has been less effort to develop poverty/environment maps. In our approach we use statistical estimation techniques (small area estimation) to overcome the typical limitations in the geographic coverage of household welfare that surveys provide and the lack of welfare indicators in the census data. We also include environmental information to assess these changes. Note that we use bio-physical information in the statistical analysis of estimating poverty indicators at the level of households and their local areas.

We adopt the approach developed by Elbers *et al*. (2003) and modified by Hoogeveen *et al.* (2004). In addition, we include bio-physical information as suggested in Okwi *et al.* (2005). The method is typically divided into three stages:

- Stage 0 involves identifying variables that describe household characteristics that may be related to income and poverty and that exist in both the household survey and in the census;
- Stage 1 estimates a measure of welfare, usually per capita expenditure, as a function of these household characteristics using regression analysis and the household survey data.. Bio-physical variables are included to minimize the variation of the location effect as part of the residuals (see Okwi et al., 2005);
- Stage 2 applies the results of the regression equation in stage 1 to the same household characteristics in the census data, predicting per capita expenditures for each household in the census. This information is then aggregated up to the desired administrative unit, such as a district or county, to estimate poverty indicators and their standard errors.

After a set of common variables has been identified, a model for per capita expenditure in 1999 can be estimated with household characteristics from the year 1991 as regressors. Estimating a model of future expenditure on past household characteristics is unusual (though less so for permanent income adherents), but recall that it is our objective to estimate the conditional expectation of expenditure for 1999 and not a causal relation (see Hoogeveen *et al.*, 2004). The model is only usable if its coefficients are estimated accurately (to limit the variance attributable to model error) and if a reasonably high R^2 (to assure disaggregation for small target populations) is obtained. If these conditions are met, updating small area welfare estimates is feasible without the need for a new census. Elbers *et al.* (2003) and Hoogeveen *et al.* (2004) describe these methods in more detail and their applications. As in Hoogeveen *et al.* (2004), the method of estimating future expenditures is based on one regression equation for all four regions, while in Okwi *et al.* (2005) four regression equations were used for four rural areas. Table B.1 in Appendix B presents the first stage regression results for 1999.

3. Results

There have been attempts to link poverty to other socio-economic factors that do not follow administrative boundaries (e.g. ILRI 2002), suggesting that combining poverty with other information (in this case on livestock) is key for a convincing integrated frame-

work to address poverty issues for pastoralist populations. For Uganda, where the majority of the households are involved in agriculture, this finding motivates our attempt to combine poverty and environmental information. Further, to explain the link between certain bio-physical characteristics and poverty, we use overlays presented in the appendices. The overlays are simply meant to provide a visual explanation of the relationship between poverty and land-use. The overlays help us to answer the following questions: Where are the poor? Which poor (rich) areas have similar types of land-use features? Which areas provide which type/amount of ecosystem services? How do the land-use types overlap with poverty? How does the location of poverty compare to the distribution of ecosystem services? This information may help policymakers to design effective policies to improve the situation. For detailed maps, see the poverty and biomass maps for all strata in Appendix A.

3.1 Poverty and land use in 1992

Okwi *et al. (*2005) prepared similar poverty estimates for 1992. The combination of poverty incidence maps (Appendix D) and the land use in Appendix A enables us to identify the poverty hotspots and correlate them with the type of land use in the area. According to Table B.3 in Appendix B, poverty incidences were higher in the North and Northeast. The type of land use in these areas is typically grassland and woodland. Economically, grasslands do not provide high returns to households and most of the households found in the grasslands are pastoralists. It is therefore not surprising that the areas of the north are generally poor. These areas are also characterized by poor climate and relatively less fertile soils compared to the Central region. Moreover, the region is also faced with a 17 year civil war which has affected human well being in the area. The parts of the Northern region that show less poverty are those situated in the south, next to Lake Kyoga. These areas generally have low poverty rates and are generally wetlands. Typically, wetland farming (rice) is taking place in this area and this could explain the fact that households in this area are less poor. In Uganda, rice growing is becoming a major income source for households living near the wetlands.

Another picture that emerges from the north is that poverty is more pronounced in the parts which are typically wooded and grassland areas and less pronounced in the degraded lands of all the regions. The implication of the later result is that the poor are actually using the ecological resources to improve their welfare but in the process they degrade the natural environment as well. However, a contrasting picture emerges from the grassland areas in Western and Northern regions which portray less and more poverty respectively. A question that emerges is why the difference? The difference could be that the pastoral lands in Western Uganda have been modified by the people to produce cross breed high yielding cattle which directly improved their welfare, while the pastoralists in the North are still held with the traditional norms of cattle rearing.

The Eastern and central region portray another interesting picture. The biomass map shows considerably more degradation in the areas surrounding Lake Victoria and the Mabira forest. The poverty map, however, shows that these areas are relatively less poor (30-40 percent) compared to the areas in the same region. These maps reveal how land use (degradation) could be helping reduce poverty among rural households living along the Mabira forest and Lake Victoria. It should be noted that this explanation does not

imply causality. Similarly, the land use map shows that areas that have typically high subsistence farming are generally poorer than the degraded areas.

3.2 Poverty and land use in 1999

The poverty mapping method also generates estimates for changes in poverty and the environment. In this section, we show how changes in poverty between 1991 and 1999 are related to changes in land use over the same period. Land use change refers to any increase or decrease in the proportion of land area under any type of land use. This land may be converted to any other type of land use e.g. wetlands being reclaimed for subsistence farming or urban areas growing to reclaim some subsistence farm areas.

The spatial patterns in county poverty rates are shown in Appendix C. These maps provide considerably more detail than the regional poverty map. The results from the analysis of poverty changes are encouraging, with large and widespread decreases in poverty seen countrywide. These trends should be viewed as indicative only, as cautious interpretation of the 1999 estimates is required due to the relatively small number of households surveyed in 1999. The 1999 maps will be updated to 2003 soon, making use of the new census data. The highest drops in poverty in rural areas between 1992 and 1999 can be seen in Central and parts of Western region in the districts of Kibaale, Luwero, Bushenyi, Rakai, Mpigi and Kisoro. Poverty was observed to have increased in Arua, Moyo and Apac in Northern region and Kasese district in Western. At the county level, the maps demonstrate how almost all rural areas in Uganda benefited from the growth that took place during the 1990's. Poverty worsened in 8 percent of Uganda's rural counties during this period. In terms of inequality, increasing inequality was observed in Northern region and some districts in Western region including Masindi, Kasese and Bundibugyo.

The maps showing how poverty has changed at the sub-county level between 1991 and 1999 can be related to the changes in the environment. Appendix C typically shows which areas have had major changes in land use. With the exception of a few areas in the four regions, all the other districts and counties in Uganda have not experienced major changes in land use.

3.3 Regional developments

Table 2 below shows the changes in poverty and land use by region between 1991 and 1999. The facts presented in the table are corroborated by the maps presented in the appendices.

Central region stood out as the least poor region in 1992 and 1999 for both rural and urban areas (Okwi *et al.,* 2005). However, the land use maps show increasingly more degraded areas. The region is mainly covered with subsistence farmlands. Between 1991 and 1999 the proportion of subsistence farmlands have increased in terms of the total land area. Central region is the main coffee growing area in Uganda and has benefited from the rapid growth in coffee production during the 1990's. However, as can be seen from Table 1 and the maps in the appendices, the areas that have experienced increases in degradation (forest) also have the least poor population. Similarly, areas that are near Lake Victoria, mainly wetlands, have experienced far more declines in poverty than the

others. This relationship points to reclamation of wetlands and degradation of forests during the period 1991-1999. A relatively large population is involved in fishing in this area. Other land use variables that have experienced declines include plantation forests (hard and soft wood), grasslands, tropical high forests and woodlands.

With a rural population of 3.7 million people and 0.3 million found in urban areas, Eastern region demonstrated the widest variability in poverty levels in 1999. Jinja district had the lowest poverty (38 percent) in 1992 while Kumi had the highest at 82 percent. County level variations were even higher. Like in the Central region, land use mainly changed against forest cover (soft and hard woodlots) and tropical high forests. Forest Degradation increased and was highest in the wealthy counties near Jinja town. Poverty remained high in the grassland and wooded areas of Kumi, Katakwi and Soroti districts. However, areas near Mt. Elgon experienced increased degradation and decreased poverty, an indication that the population in these areas is harnessing the forest resources from the Mt. Elgon reserve to improve their welfare. Increased land area under rice farming could also explain part of the reduction in poverty in this region. The proportions of subsistence farmlands and subsistence wetlands remained almost the same as in 1991.

Table 2 Changes in Sub county poverty and land use area 1992 to 1999.

	Regions			
Poverty and Land use net changes (percentages)	Central	Eastern	Northern	Western
Poverty				
Poverty rate (FGT0)	–	–	–	–
Poverty depth (FGT1)	–	–	–	–
Poverty severity (FGT2)	–	–	–	–
Land use type				
Plantations Hardwoods – deciduous trees/broadleaves (hardwood)	–	–	+	–
Plantations Softwoods- coniferous trees	–	–	–	0
Tropical high forest (THF)- Normally stocked	–	–	No data	0
Tropical high forest (THF) – Degraded or depleted	+	+	No data	+
Woodlands – trees and shrubs (average height > 4m)	–	+	–	–
Grasslands –rangelands, pastureland, open savannah including scattered shrubs and thickets	–	–	+	0
Wetlands – wetland vegetation; swamp areas, papyrus and other sedges	0	+	+	0
Subsistence Farmlands –mixed farmland, smallholdings in use or recently used, with or without trees	+	0	–	+
Commercial Farmlands – mono cropped, non seasonal farmland usually without any trees for example tea and sugar estates	+	0	0	0
Water – Lakes, rivers and ponds	0	0	0	0

Source: Authors computations

With over 75 percent of the population poor in 1992, Northern region remained the poorest region in Uganda in 1999. The poorest districts were Kotido and Kitgum with poverty incidences of 91 percent while Arua and Lira stood out as the least poor districts (appendix B). There was significantly more variation in poverty in this region at both the district and county levels. This region, in contrast is generally wooded and grassland with a few pockets of wetlands. A few counties have poverty below 60 percent. There have been increments in the plantation woodlots, wetlands and wooded areas. Generally the state of the environment has not changed much since 1991 probably because most of the land use activities have been hampered by the war. The high incidence of poverty in this area is due to the fact that this is one of the most semi arid parts of Uganda, and the sandy soils make it difficult to practice intensive agriculture. This area is generally poorly served with roads and therefore access to markets is difficult. A relatively small population is involved in fishing in Lake Kyoga and River Nile. The fishing areas and wetlands generally show improvements in welfare. The typical grassland and wooded areas remained with the highest incidence of poverty.

Western Region is ranked the second least poor in Uganda. More than half the rural population and one third of the urban population lived below the poverty line in 1992. Rural poverty was highest in Kisoro and lowest in Mbarara district. In 1999, there was a lot of variation in poverty incidence in this region. Masindi, Bundibugyo and Kasese had greater than 50 percent poverty incidence while relatively wealthy districts such as Mbarara and Bushenyi had poverty levels below 20 percent. This region showed the highest declines in poverty in the 1990's. The area generally has a mix of subsistence farming and cattle rearing. More areas have been reclaimed from grasslands into farms. However, there are pockets of high degradation between 1991 and 1999 in the North-western parts of the region and the proportion of hard wood plantation forests generally decreased. These are areas close to the mountainous parts of Rwenzori with difficult access to roads and markets. Areas near the mid western have benefited from flat land and improved transportation (roads), all of which reduce poverty rates. The grasslands have been remained more less the same although in a few areas that were formerly wooded and grasslands have been transformed into subsistence farms. Evidence of reduced poverty is clear in mid western parts.

As mentioned earlier, the estimates of changes in poverty must be interpreted with caution. For the 1999 poverty rates, there were relatively a small number of households included in the panel, leading to relatively high margins of error in the poverty estimates. Similarly, the changes in land use are not bound by district and county boundaries and therefore subject to some measurement error. As already indicated, land use does not necessarily confine itself to administrative boundaries.

Finally, two notes of warning about putting small area welfare estimates on the map. This paper has placed considerable emphasis on the fact the census based poverty estimates are associated with a standard error. The maps do not reflect this, and in various instances counties that are classified differently on the map, have means for which a t-test cannot reject that they are identical. Next, poverty incidence is just one way to report poverty. Instead of reporting the fraction of poor, a geographic profile of welfare could also take into account land area and report poverty density –i.e. the number of poor per square kilometer. If one were to do so the geographic poverty profile becomes very dif-

ferent, with poverty being least an issue in the North and being most urgent near the Rwandan border in the South West and South of Mt Elgon in the East.

4. Conclusions and implications for policy programs

4.1 Conclusions

This analysis explored the geographic relationship between welfare and the environment by combining census, survey and bio-physical data to generate spatially disaggregated poverty/biomass information for rural Uganda. The study makes a methodological contribution to small area welfare estimation by exploring how the inclusion of bio-physical information and panel data may improve the analysis of poverty in Uganda. By combining the generated poverty estimates with national biophysical data, this study explores the contemporaneous correlation between poverty (welfare) and natural resource degradation at a level of geographic detail (sub-county) that has not been feasible previously. We use association relationships are used to explain welfare and the environment rather than causal relationships. However, the resulting estimates of poverty measures have improved by the inclusion of bio-physical information. In some cases the levels of poverty measures have changed. For North Uganda, the poverty gap and poverty gap squared increased compared to the estimates without biophysical information.

By providing comparable welfare and biophysical information for many data points, this study solves many problems faced by many previous studies. For instance, previous studies (see Atkinson and Brandolini, 1999) on poverty and the environment were based on case studies which are unrepresentative. This study presents results of a representative sample and population. Secondly, previous studies have also been cross-sectional thus raising data incomparability problems. By using data from one country and collected by the same institution, with comparable questions in the questionnaires and within a period of time less than 2 years, data incomparability problems are solved. Thirdly, this study has provided a practical analysis of the link between welfare and the environment. Other studies have only looked at the theoretical link between poverty and environmental degradation (Ambler 1999; Barbier, 2000; Roe, 1998; Chomitz, 1999; Ekbom and Bojo, 1999). This study has shown that accounting for spatial differences in welfare is key to high precision maps and explaining poverty environment relationships.

Updating requires panel data and estimation of an updated poverty map and will typically be done on a smaller survey data set than the one used to generate the poverty map for the census year. In the case of Uganda, the 1992 rural poverty map is based on a survey with 6,396 observations, whereas the updated map is based on 1,058 observations. This has implications. Updated welfare estimates for urban areas are not derived and the estimation procedure had to be adjusted. For instance one expenditure model with regional interaction terms was estimated instead of one for each of the four rural strata; district dummies could not be used because not all districts were represented in the panel and indicators of ethnicity obtained from the census were used instead. These deviations from the preferred poverty mapping methodology require careful scrutiny of the generated welfare estimates. Fortunately, in a typical case where a poverty map is updated, small area estimates already exist for the census year. The second important result from this exercise is that one should not only estimate an updated poverty map for the year of

interest, but an 'updated' map for the census year should also be generated. The comparison of the updated census year map, with the actual poverty map for the census year, allows checking the accuracy of the method. Together with the R2 of the updated expenditure model and the accuracy with which stratum level welfare estimates from the sample survey are replicated, it guides the decision on how to use updated small area results.

4.2 Implications for policy and programs

The main objective of this project is to examine the spatial patterns in poverty and the environment, with the idea that this information is useful for targeting poverty alleviation and environment conservation programs. The study was not designed to assess specific policy options for poverty reduction and environmental conservation. The results do, however, provide some indirect implications for policy and programs. In this section, we discuss some of those implications.

The most obvious application of the results presented in this report is in improving information on the spatial distribution and changes in poverty for the purpose of tracking and targeting poverty alleviation programs. Not only do the results provide information on the changes in poverty in Uganda between 1992 and 1999, but they also provide information on the accuracy of these estimates. In addition, by generating information on alternative poverty measures and including biomass data, they allow program designers to target assistance on counties and sub counties with the greatest depth or severity of poverty and environmental deterioration.

If most poor people live in less poor areas or environmentally stable areas, what are the implications for targeting poverty alleviation or environmental conservation programs? In particular, should poverty alleviation programs concentrate their efforts on areas with the greatest poverty density? Should environmental conservation programs concentrate on areas with the highest degradation or reclamation? The answers depend on the type of poverty alleviation and environmental conservation program, as discussed below.

Several development oriented programs are relatively untargeted and may lift the income of all households in an area. For example, rural based financial schemes, better roads, better health care, and financial support to local government may have indirect effects on household incomes. If we assume the development program has a fixed cost per inhabitant, then such a program will have a greater effect on poverty if it is concentrated on poor areas. In such areas, a higher percentage of the population is poor so a higher percentage of the beneficiaries will be poor. Thus, the government achieves more poverty reduction per dollar spent. This strategy is certainly true if the goal is to reduce the depth of poverty (P1) and it is probably true if the goal is to reduce the incidence of poverty (P0) as well. It may also indirectly affect land use and especially forest degradation if these programs bring with them alternative sources of higher incomes thus diverting attention from the natural resources such as forests. However, the effect may be negative as well.

For other programs that are directly targeted to poor households, for example income transfers, food for work, or social service fee exemptions, if the goal is to provide the same level of assistance to each poor person, the program should spend more overall in

areas with many poor people, although more money per inhabitant in areas with high poverty rates.

The assumption behind these guidelines is that the cost of providing the program is constant in per capita terms, implying that the cost is not affected by population density. However, some programs, such as rural electrification and extension, and water provision will cost more in per capita terms in low-density areas. Meanwhile, programs such as land-intensive programs (roads and parks), may be more expensive in a high-density area.

In terms of environmental policy, the analysis of the relationship between poverty and the environment reveals that some changes in poverty in rural areas are highly related to changes in land use in these areas. As explained earlier, a small number of land-use and market access variables are closely related to poverty changes. This finding should be treated with caution because it is not possible to design policy interventions that directly influence some land use variables. So those living in districts with extensive land covered by woodlands, grasslands and impediments such as steep slopes, rocks and poor soils may be caught in spatial poverty traps from which it is difficult to escape.

Rural roads or market access is one of the few geographic variables that can be influenced by policy. Although the government cannot reduce the actual distance to cities, it can reduce travel time and cost which is probably the relevant variable. However, roads may also allow greater exploitation of natural resources such as trees (charcoal and firewood) since markets will be easily accessible. Also goods produced more cheaply elsewhere (such as rice) to enter the region and compete with local production hence affecting household incomes. But this will be offset by better access to high-income markets outside the districts.

In addition, land use is only a limiting factor in poverty reduction to the extent that people are not able to migrate. To the extent that migrants are able to raise their living standards without negatively affecting others, migration can be an effective tool to reduce poverty and environmental degradation. This implies that the government should not exclude migration as a possible development strategy, particularly for districts that are severely constrained by agro-ecological factors. Easing migration restrictions would allow people from areas with poor land and degraded areas to raise their incomes and reduce poverty. Although migrants from rural areas to the cities tend to be initially poorer than their urban neighbors, thus contributing to a more visible increase in the number of urban poor, the relevant question is whether the standard of living of the migrants is better than it would be if they had not migrated.

Finally, it is important to avoid the idea that the type of land use will prevent any development in disadvantaged and poor areas. The fact that land use variables are good predictors of poverty rates across counties at one point in time does not mean that they are good predictors of poverty over time for a given area. The results from the regression analysis clearly display regional up to county level variation in spatial correlation between bio-physical and poverty information and therefore imply region specific policy designs.

In terms of future research, with more information, the causal relationship will be analyzed in more detail. Another conclusion that we reached is that without further verifica-

tion the updated results should not be used as indicators for the welfare in specific sub-counties, counties or districts.

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Appendix A: Uganda Land use changes between 1992 and 1999

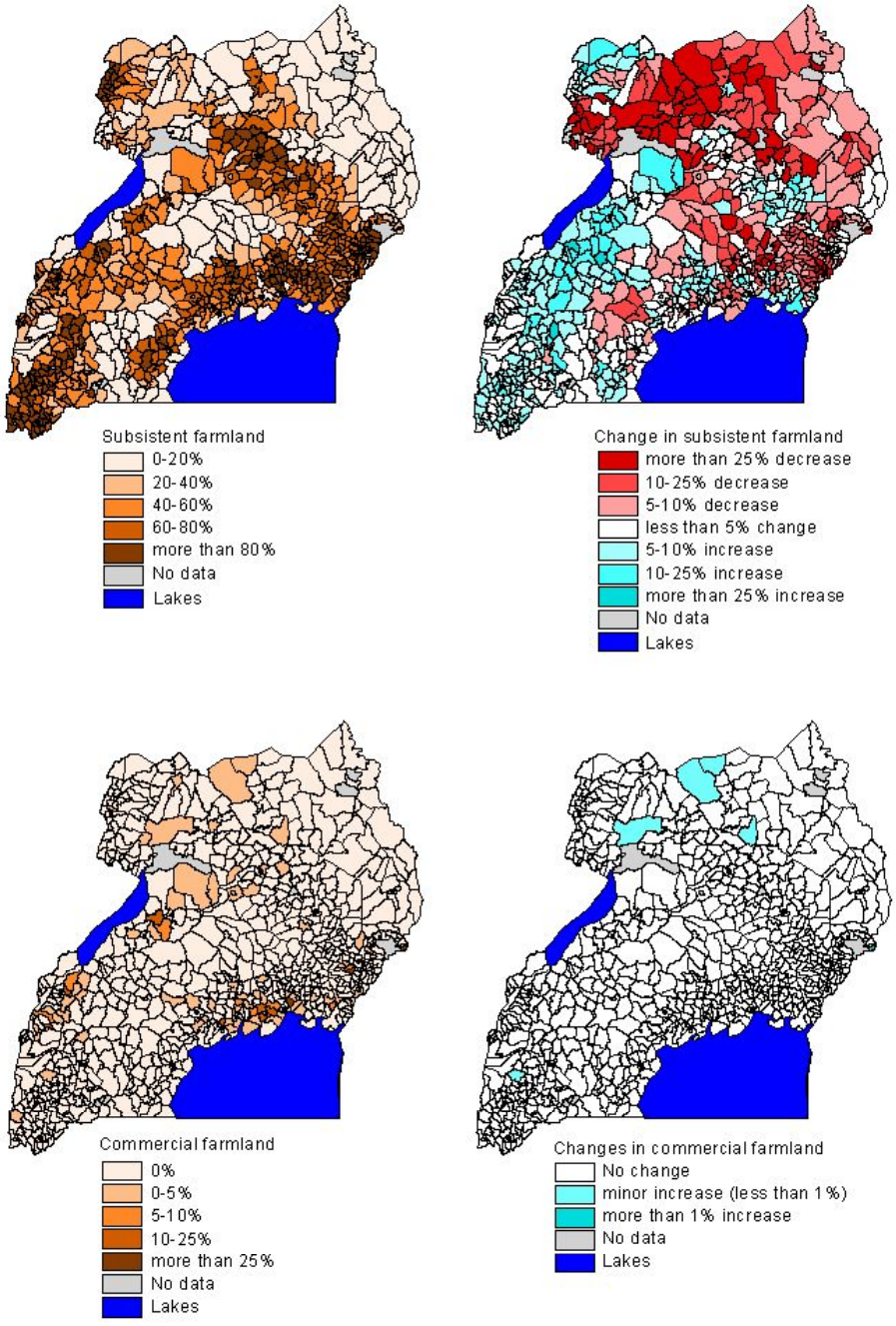

Figure A.1 Subsistent and commercial farmland in 1999 and the changes compared to 1991.

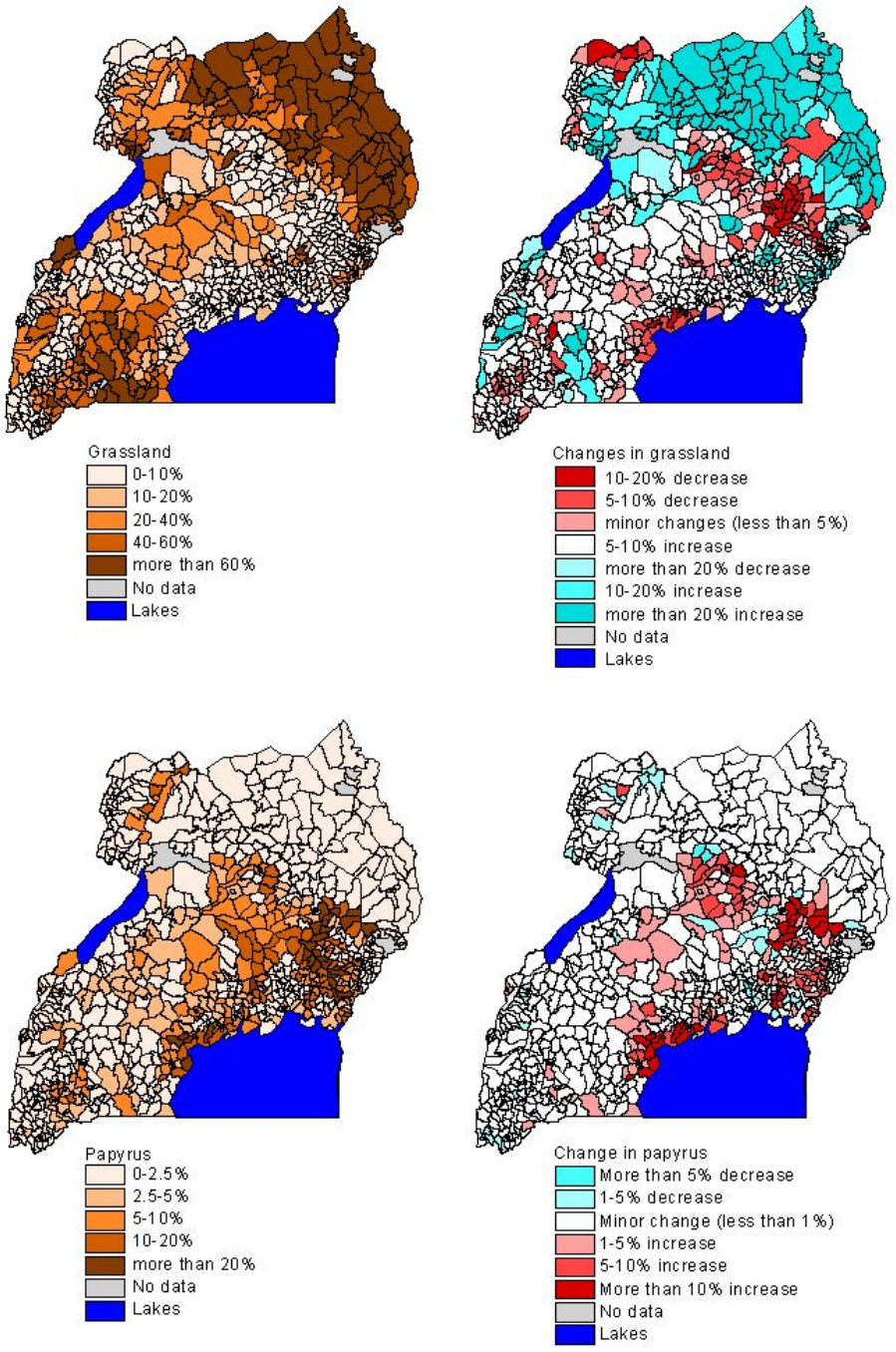

Figure A.2 Grassland and Wetlands in 1999 and the changes compared to 1991.

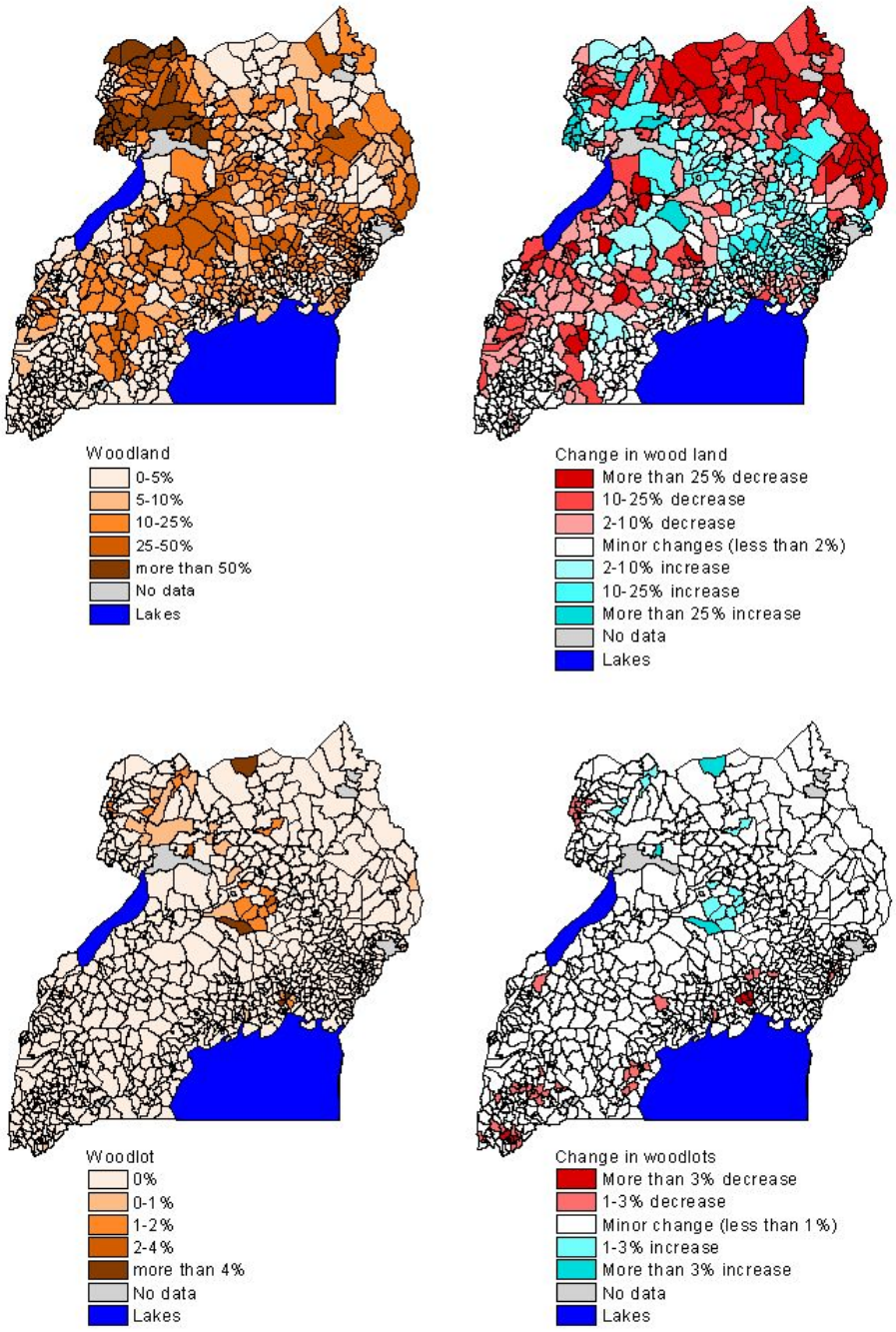

Figure A.3 Woodland and woodlots in 1999 and the changes compared to 1991.

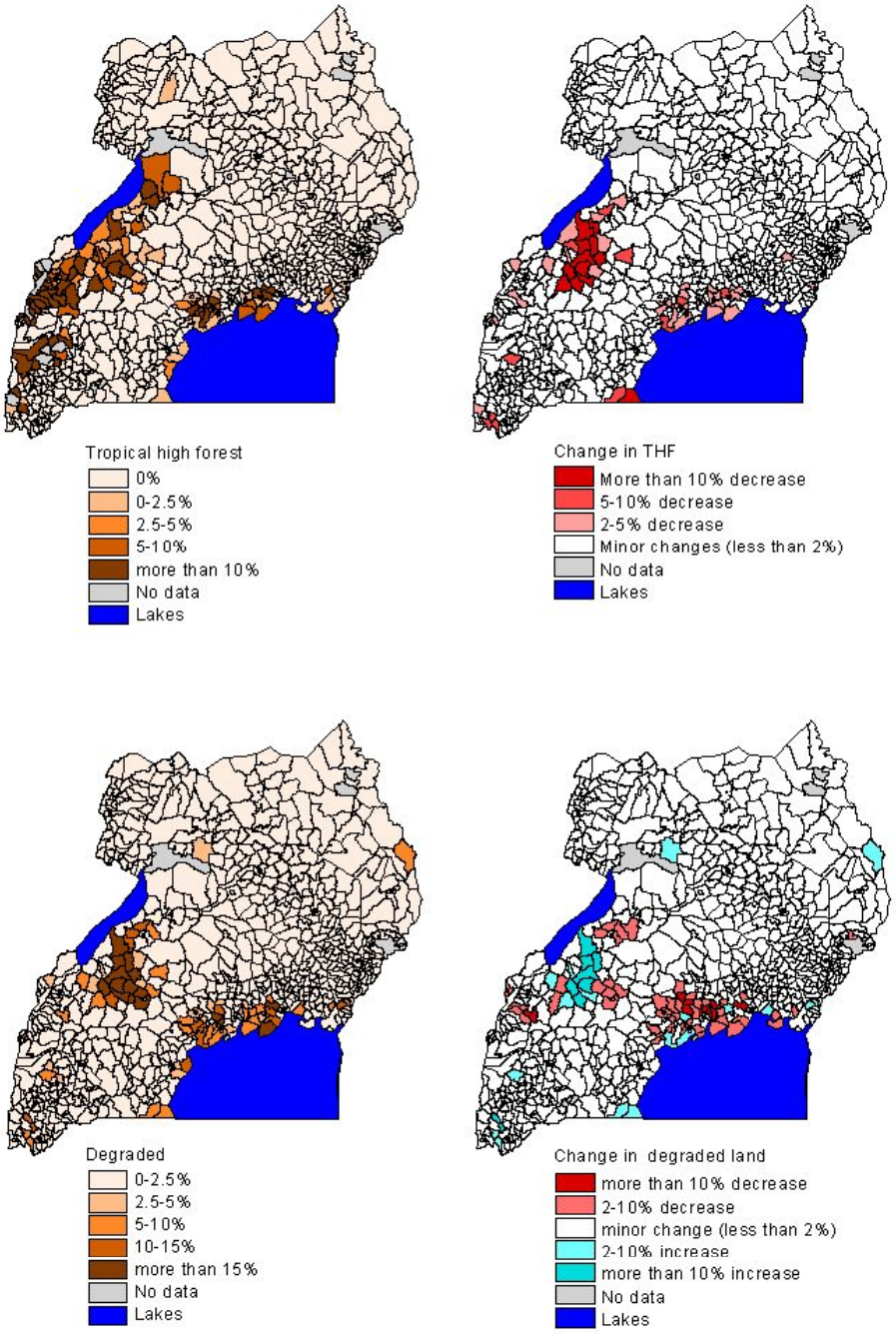

Figure A.4 Tropical high forest (THF) and degraded THF in 1999 and the changes compared to 1991.

Appendix B: Regression results

Table B.1 First stage regression results 1999.

Variables	Coefficient	SE
Intercept	10.07	0.06
Household size=4	0.10	0.04
Number of males with primary school education	0.02	0.01
Proportion of females aged 6-14 squared	0.59	0.21
Prop. of spouses with education at least secondary school	0.28	0.09
Proportion of females aged 30 to 49	0.33	0.11
Highest number of years of education in household*Muganda tribe	0.02	0.01
Interaction terms		
Log of household size*No bathroom	-0.29	0.05
Household size 1-3 * Munyoro tribe	0.49	0.18
Household size 1-3*Mutoro tribe	-0.46	0.13
Highest No of yrs of educ. in hh*Share of parish within 5km of tarmac road	-0.01	0.00
Number of males with at least secondary school*free house	1.72	0.47
Head female, divorced, separated or widowed *heads age squared* Mukonjo tribe	0.00	0.00
Head female, divorced, separated or widowed *heads age squared* *Share of commercial farms	0.00	0.00
Head female, divorced, separated or widowed *heads age squared* lighting electricity	0.00	0.00
Iron roof*adult equivalence size*Muganda tribe	1770.16	733.14
Iron roof* adult equivalence size*share of parish within 1 km of track* dummy North	-1.79	0.57
Log household size*Heads activity clerical work* dummy North	65.11	17.83
Log household size*heads activity other* dummy North	-0.54	0.08
Household size 1-3* household activity other * dummy North	-0.53	0.12
Highest No of yrs of educ. in household *Karimojong tribe*dummy North	-0.33	0.13
Mean number of years of education of adults * Karimojong tribe *dummy North	1.38	0.40
Mean number of years of education of adults *Madi tribe*dummy North	-0.36	0.10
Number of males with at least secondary school*share of parish under papyprus*dummy North	5.87	2.87
Head's age squared*share of parish under commercial farm*dummy North	0.00	0.00
Female head, divorced or widowed*Head's age squared*Electricity lighting*dummy North	0.32	0.10
Household size 1-3*Karimojong tribe *dummy Eastern	-90.53	36.36
Household size 1-3*Madi tribe *dummy Eastern	66.02	27.56
log household size*Japdadhola tribe*dummy Western	80.48	23.87
Mean education deficit of children aged 7-1 8*Mugisu tribe*dummy Western	-0.37	0.12
Number of males with at least secondary school *Acholi tribe*dummy Western	-109.76	34.34
Heads age squared*Household heads age squared*dummy Western	0.01	0.00
Log household size*share of parish degraded*dummy Western	-0.62	0.27
Highest No of yrs of educ. in household * stone wall*dummy Western	3.17	0.69
Household heads age squared*Lugbar tribe*dummy Western	0.00	0.00
Household heads age squared*Heads activity clerical worker*dummy Western	0.02	0.01
Iron roof*adult equivalent size*Mukiga tribe*dummy Western	-0.17	0.03
Female head, divorced or widowed *Head's age squared*Lugbar tribe*dummy West	-0.04	0.01
Heads activity is student	-8.35	4.96
Live in personal house	7.82	3.45
Tribe Rwanda	0.36	0.18
Number of observations	1058	
Number of Clusters	163	
Adjusted R^2	0.34	

Appendix C. Poverty estimates at county level, 1999

Table C.1 Poverty estimates including biomass for rural Central region, 1999.

Region / District/County	Estimated number of Poor 1999 (std. Error)	Headcount Index: (std. Error)	Poverty Gap (std. Error)	Number of Individuals 1999
KALANGALA DISTRICT	**1,984 (314)**	**13.9 (2.20)**	**3.3 (0.60)**	**14,251**
BUJUMBA	1,039 (172)	14.3 (2.36)	3.4 (0.66)	7,271
KYAMUSWA	945 (157)	13.5 (2.25)	3.2 (0.61)	6,980
KIBOGA DISTRICT	**38,860 (2,803)**	**29.0 (2.09)**	**7.4 (0.68)**	**134,127**
KIBOGA	38,860 (2,803)	29.0 (2.09)	7.4 (0.68)	134,127
LUWERO DISTRICT	**75,134 (7,845)**	**18.5 (1.93)**	**4.4 (0.56)**	**406,497**
BURULI	19,877 (2,357)	22.0 (2.61)	5.4 (0.76)	90,306
KATIKAMU	21,895 (2,628)	18.4 (2.21)	4.4 (0.63)	118,920
NAKASEKE	15,265 (1,623)	16.8 (1.79)	4.0 (0.50)	90,672
WABUSANA	18,097 (1,812)	17.0 (1.70)	4.1 (0.50)	106,599
MASAKA DISTRICT	**158,345 (10,005)**	**21.8 (1.38)**	**5.3 (0.43)**	**724,999**
MAWOGOLA	27,169 (2,053)	22.9 (1.73)	5.6 (0.53)	118,664
BUKOMANSIMBI	23,842 (2,017)	19.0 (1.61)	4.6 (0.45)	125,259
BUKOTO	74,317 (4,611)	23.0 (1.43)	5.7 (0.46)	322,480
KALUNGU	28,041 (1,949)	20.1 (1.40)	4.9 (0.43)	139,212
LWEMIYAGA	4,976 (376)	25.7 (1.94)	6.4 (0.63)	19,384
MPIGI DISTRICT	**148,700 (17,221)**	**19.7 (2.28)**	**5.1 (0.80)**	**755,286**
BUTAMBALA	12,806 (1,672)	18.3 (2.39)	4.6 (0.81)	69,955
GOMBA	23,544 (2,879)	20.4 (2.49)	5.1 (0.83)	115,603
KYADONDO	34,736 (4,600)	17.4 (2.30)	4.5 (0.77)	199,980
BUSIRO	47,176 (5,551)	20.0 (2.35)	5.1 (0.83)	236,212
MAWOKOTA	30,438 (3,552)	22.8 (2.66)	5.9 (0.97)	133,536
MUBENDE DISTRICT	**142,828 (10,035)**	**31.0 (2.18)**	**8.3 (0.81)**	**460,303**
BUSUJJU	17,780 (1,257)	27.2 (1.92)	6.9 (0.62)	65,446
BUWEKULA	39,978 (3,059)	33.3 (2.55)	8.9 (0.90)	119,959
KASSANDA	47,098 (3,554)	32.9 (2.48)	9.1 (1.05)	143,303
MITYANA	37,973 (2,606)	28.9 (1.98)	7.6 (0.70)	131,595
MUKONO DISTRICT	**174,044 (11,798)**	**24.3 (1.65)**	**6.3 (0.55)**	**715,030**
BUVUMA ISLANDS	3,667 (321)	20.1 (1.76)	4.9 (0.52)	18,232
NTENJERU	34,736 (2,627)	26.7 (2.02)	6.7 (0.64)	130,069
MUKONO	34,966 (2,605)	21.1 (1.57)	5.3 (0.51)	165,894
BUYIKWE	47,996 (3,206)	25.3 (1.69)	6.8 (0.64)	189,676
BBAALE	21,371 (1,803)	26.0 (2.19)	6.5 (0.68)	82,346
NAKIFUMA	31,307 (2,151)	24.3 (1.67)	6.3 (0.57)	128,813
RAKAI DISTRICT	**100,071 (6,048)**	**27.5 (1.66)**	**6.9 (0.54)**	**364,352**
KABULA	14,683 (978)	31.4 (2.09)	8.0 (0.68)	46,793
KAKUUTO	16,894 (1,138)	25.5 (1.72)	6.4 (0.54)	66,184
KOOKI	37,146 (2,429)	28.6 (1.87)	7.3 (0.60)	129,874
KYOTERA	31,348 (2,345)	25.8 (1.93)	6.4 (0.60)	121,501
Central Region	**839,965 (49,690)**	**23.5 (1.39)**	**6.0 (0.47)**	**3,574,845**

Table C.2 Poverty estimates including biomass for rural East Uganda, 1999.

Region / District/County	Estimated number of Poor 1999 (std. Error)	Headcount (std. Error)	Poverty Gap (std. Error)	Number of Individuals 1999
IGANGA DISTRICT	**290,266 (16,663)**	**32.7 (1.88)**	**8.6 (0.66)**	**886,353**
LUUKA	37,913 (2,527)	29.4 (1.96)	7.5 (0.64)	128,923
BUNYA	66,053 (3,846)	31.9 (1.86)	8.3 (0.65)	206,788
BUKOOLI	74,468 (4,270)	33.1 (1.90)	8.7 (0.68)	224,720
BUSIKI	40,310 (2,408)	33.7 (2.01)	8.8 (0.71)	119,780
KIGULU	45,586 (3,037)	35.1 (2.34)	9.3 (0.83)	129,803
BUGWERI	25,936 (1,618)	34.0 (2.12)	8.9 (0.77)	76,339
JINJA DISTRICT	**41,228 (4,340)**	**20.1 (2.12)**	**5.1 (0.63)**	**204,694**
BUTEMBE	16,858 (1,838)	19.9 (2.17)	5.3 (0.74)	84,707
KAGOMA	24,370 (2,592)	20.3 (2.16)	4.9 (0.63)	119,987
KAMULI DISTRICT	**188,936 (12,276)**	**40.3 (2.62)**	**11.1 (0.99)**	**468,546**
BUZAAYA	38,264 (2,370)	41.5 (2.57)	11.5 (0.99)	92,224
BUDIOPE	50,832 (3,706)	39.8 (2.90)	10.9 (1.09)	127,806
BULAMOGI	41,124 (2,803)	40.5 (2.76)	11.1 (1.03)	101,548
BUGABULA	58,716 (3,748)	40.0 (2.55)	10.9 (0.97)	146,968
KAPCHORWA DISTRICT	**30,254 (3,017)**	**29.7 (2.96)**	**7.6 (0.92)**	**101,941**
KONGASIS	6,668 (718)	29.1 (3.13)	7.3 (0.98)	22,935
KWEEN	11,008 (1,107)	30.7 (3.09)	8.0 (0.96)	35,823
TINGEY	12,579 (1,239)	29.1 (2.87)	7.4 (0.90)	43,183
KUMI DISTRICT	**63,148 (4,796)**	**28.7 (2.18)**	**7.4 (0.74)**	**219,991**
NGORA	15,738 (1,204)	27.1 (2.07)	6.9 (0.67)	58,157
BUKEDEA	22,721 (1,906)	30.9 (2.59)	8.2 (0.94)	73,604
KUMI	24,688 (1,809)	28.0 (2.05)	7.1 (0.69)	88,230
MBALE DISTRICT	**161,713 (13,913)**	**25.2 (2.17)**	**6.3 (0.67)**	**641,133**
BULAMBULI	14,779 (1,267)	23.1 (1.98)	5.7 (0.61)	63,997
BUDADIRI	35,543 (3,127)	24.9 (2.19)	6.2 (0.67)	142,776
BUNGOKHO	52,109 (5,411)	29.0 (3.01)	7.4 (0.96)	179,756
MANJIYA	18,417 (1,567)	23.5 (2.00)	5.7 (0.60)	78,348
BUBULO	40,865 (3,455)	23.2 (1.96)	5.6 (0.59)	176,256
PALLISA DISTRICT	**87,667 (7,597)**	**25.2 (2.18)**	**6.3 (0.67)**	**348,498**
BUDAKA	26,703 (2,561)	27.0 (2.59)	6.9 (0.82)	98,891
BUTEBO	14,931 (1,223)	23.9 (1.96)	5.9 (0.60)	62,403
KIBUKU	24,138 (2,298)	26.8 (2.55)	6.7 (0.79)	90,130
PALLISA	21,895 (1,864)	22.6 (1.92)	5.5 (0.55)	97,074
SOROTI DISTRICT	**145,856 (10,002)**	**39.8 (2.73)**	**11.1 (1.04)**	**366,359**
KALAKI	15,347 (1,073)	38.2 (2.67)	10.5 (0.99)	40,191
KAPELEBYONG	9,484 (748)	44.9 (3.54)	13.2 (1.50)	21,138
SERERE	20,717 (1,511)	37.8 (2.76)	10.2 (0.98)	54,761
USUK	27,046 (1,870)	39.5 (2.73)	11.0 (1.08)	68,505
SOROTI	29,643 (1,917)	42.0 (2.72)	11.9 (1.11)	70,495
KABERAMAIDO	14,365 (1,028)	38.6 (2.76)	10.7 (1.02)	37,230
KASILO	11,160 (797)	38.2 (2.73)	10.5 (1.00)	29,198
AMURIA	18,093 (1,399)	40.3 (3.12)	11.1 (1.16)	44,841
TORORO DISTRICT	**147,058 (11,799)**	**30.5 (2.45)**	**7.9 (0.81)**	**481,576**
TORORO	30,897 (2,880)	34.1 (3.18)	9.1 (1.07)	90,557
BUNYOLE	29,953 (2,398)	29.1 (2.33)	7.5 (0.76)	102,915
KISOKO (WEST)	45,279 (3,660)	29.2 (2.36)	7.4 (0.76)	155,092
SAMIA-BUGWE	40,929 (3,259)	30.8 (2.45)	8.1 (0.83)	133,012
Eastern Region	**1,156,126 (63,968)**	**31.1 (1.72)**	**8.1 (0.61)**	**3,719,091**

Table C.3 Poverty estimates including biomass for rural North Uganda, 1999.

Region / District/County	Estimated number of Poor 1999 (std. Error)	Headcount (std. Error)	Poverty Gap (std. Error)	Number of Individuals 1999
APAC DISTRICT	**314,605 (13,129)**	**76.9 (3.21)**	**34.4 (3.45)**	**409,012**
KOLE	82,820 (3,264)	79.2 (3.12)	36.4 (3.64)	104,612
MARUZI	48,696 (2,260)	75.0 (3.48)	32.9 (3.59)	64,951
KWANIA	63,078 (2,493)	80.7 (3.19)	37.5 (4.14)	78,138
OYAM	120,011 (5,404)	74.4 (3.35)	32.1 (3.07)	161,311
ARUA DISTRICT	**350,897 (18,441)**	**59.6 (3.13)**	**20.7 (1.71)**	**589,166**
TEREGO	55,579 (3,168)	57.5 (3.28)	18.9 (1.70)	96,591
VURRA	35,684 (1,981)	57.3 (3.18)	18.8 (1.63)	62,280
ARINGA	56,957 (3,513)	58.5 (3.61)	19.6 (1.84)	97,309
AYIVU	58,369 (3,488)	56.1 (3.35)	18.9 (1.69)	104,107
KOBOKO	33,512 (2,107)	59.3 (3.73)	20.2 (1.91)	56,479
MADI-OKOLLO	48,034 (2,633)	72.2 (3.96)	32.1 (4.47)	66,488
MARACHA	62,761 (3,421)	59.3 (3.23)	19.6 (1.70)	105,912
GULU DISTRICT	**202,629 (11,489)**	**76.2 (4.32)**	**35.6 (4.07)**	**265,950**
KILAK	63,009 (3,410)	78.3 (4.24)	37.2 (4.14)	80,422
ASWA	44,402 (2,840)	73.0 (4.67)	34.0 (4.05)	60,819
NWOYA	26,847 (1,616)	76.4 (4.60)	35.0 (4.28)	35,138
OMORO	68,372 (3699)	76.3 (4.13)	35.5 (3.99)	89,571
KITGUM DISTRICT	**271,426 (9,,478)**	**83.9 (2.93)**	**41.7 (3.48)**	**323,465**
CHUA	73,037 (2,605)	84.4 (3.01)	42.4 (3.63)	86,547
AGAGO	76,343 (2,973)	82.4 (3.21)	40.1 (3.49)	92,608
LAMWO	55,413 (1,825)	84.1 (2.77)	41.8 (3.35)	65,900
ARUU	66,634 (2,164)	85.0 (2.76)	43.0 (3.47)	78,410
KOTIDO DISTRICT	**93,673 (2,394)**	**88.8 (2.27)**	**46.1 (3.49)**	**105,444**
JIE	37,908 (961)	89.5 (2.27)	45.8 (3.40)	42,344
LABWOR	18,572 (654)	85.3 (3.00)	43.2 (3.71)	21,784
DODOTH	37,193 (913)	90.0 (2.21)	47.9 (3.65)	41,316
LIRA DISTRICT	**262,793 (12,761)**	**60.5 (2.94)**	**21.1 (1.69)**	**434,053**
ERUTE	85,810 (4,345)	59.1 (2.99)	20.6 (1.59)	145,302
KIOGA	34,407 (1,797)	61.5 (3.21)	22.1 (2.05)	55,972
MOROTO	67,923 (3,421)	61.7 (3.11)	21.3 (1.75)	110,014
OTUKE	26,185 (1,347)	61.8 (3.18)	21.3 (1.74)	42,351
DOKOLO	48,468 (2,453)	60.3 (3.05)	21.1 (1.82)	80,414
MOROTO DISTRICT	**90,672 (3,561)**	**83.0 (3.26)**	**45.2 (4.41)**	**109,224**
PIAN	12,224 (672)	80.1 (4.40)	43.3 (4.94)	15,266
UPE	6,131 (170)	88.9 (2.46)	49.8 (4.46)	6,893
MATHENIKO	26,039 (823)	86.7 (2.74)	47.7 (4.41)	30,044
BOKORA	24,139 (1,155)	78.1 (3.74)	41.0 (4.22)	30,892
KADAM (CHEKWII)	22,138 (818)	84.7 (3.13)	47.3 (4.51)	26,129
MOYO DISTRICT	**86,137 (6,337)**	**68.8 (5.06)**	**30.3 (4.78)**	**125,243**
EAST MOYO	41,974 (3,215)	71.3 (5.46)	32.2 (5.46)	58,891
OBONGI	12,538 (1,223)	59.6 (5.81)	22.1 (3.39)	21,045
WEST MOYO	31,624 (2,197)	69.8 (4.85)	31.6 (4.91)	45,307
NEBBI DISTRICT	**160,179 (11,004)**	**56.9 (3.91)**	**19.1 (1.86)**	**281,420**
OKORO	67,156 (4,395)	58.4 (3.82)	19.7 (1.84)	115,047
JONAM	31,423 (2,753)	51.3 (4.49)	16.9 (1.95)	61,313
PADYER	61,601 (4,097)	58.6 (3.90)	19.6 (1.94)	105,060
Northern Region	**1,833,012 (67,396)**	**69.4 (2.55)**	**29.3 (2.01)**	**2,642,977**

Table C.4 Poverty estimates including biomass for rural West Uganda, 1999.

Region / District/County	Number of Poor	Headcount	Poverty	# of individuals
BUNDIBUGYO DISTRICT	**33,994 (2,061)**	**40.2 (2.44)**	**12.1 (1.05)**	**84,468**
NTOROKO	5,160 (342)	38.9 (2.58)	11.6 (1.21)	13,263
BWAMBA	28,834 (1,780)	40.5 (2.50)	12.2 (1.06)	71,205
BUSHENYI DISTRICT	**170,597 (7,476)**	**37.4 (1.64)**	**10.7 (0.69)**	**455,848**
IGARA	53,117 (2,932)	38.2 (2.11)	11.0 (0.85)	138,941
RUHINDA	43,020 (1,883)	37.0 (1.62)	10.5 (0.67)	116,224
SHEEMA	48,106 (2,160)	37.2 (1.67)	10.7 (0.71)	129,324
BUNYARUGURU	6,082 (347)	36.6 (2.09)	10.6 (0.91)	16,618
BUHWEJU	20,272 (914)	37.0 (1.67)	10.6 (0.69)	54,741
HOIMA DISTRICT	**51,041 (7,398)**	**27.3 (3.96)**	**7.6 (1.37)**	**186,811**
BUGAHYA	32,949 (4760)	28.6 (4.13)	8.0 (1.44)	115,253
BUHAGUZI	18,092 (2662)	25.3 (3.72)	7.0 (1.28)	71,558
KABALE DISTRICT	**103,640 (7,035)**	**27.8 (1.89)**	**7.5 (0.64)**	**372,205**
RUKIGA	23,576 (1,782)	27.5 (2.08)	7.4 (0.70)	85,671
NDORWA	39,735 (2,756)	28.3 (1.96)	7.6 (0.66)	140,600
RUBANDA	40,329 (2,641)	27.6 (1.81)	7.4 (0.61)	145,934
KABAROLE DISTRICT	**239,767 (11,921)**	**42.6 (2.12)**	**12.7 (0.93)**	**562,318**
MWENGE	70,359 (3,809)	44.7 (2.42)	13.4 (1.06)	157,380
KYAKA	22,690 (1,340)	40.3 (2.38)	11.8 (1.00)	56,310
KITAGWENDA	22,443 (1,154)	39.9 (2.05)	11.7 (0.82)	56,294
KIBALE	37,879 (2,044)	37.2 (2.01)	10.9 (0.77)	101,701
BUNYANGABU	25,011 (1,423)	46.1 (2.62)	14.0 (1.15)	54,312
BURAHYA	61,385 (3,340)	45.0 (2.45)	13.7 (1.13)	136,321
KASESE DISTRICT	**68,575 (3,913)**	**34.7 (1.98)**	**10.1 (0.83)**	**197,608**
BUKONJO	42,139 (2,447)	34.8 (2.02)	10.0 (0.78)	121,153
BUSONGORA	26,437 (1,537)	34.6 (2.01)	10.3 (1.00)	76,455
KIBAALE DISTRICT	**83,607 (4,050)**	**40.5 (1.96)**	**12.4 (0.89)**	**206,618**
BUYANJA	13,750 (719)	37.1 (1.94)	11.1 (0.85)	37,047
BUYAGA	53,411 (2,632)	43.2 (2.13)	13.4 (1.00)	123,545
BUGANGAIZI	16,446 (833)	35.7 (1.81)	10.6 (0.77)	46,026
KISORO DISTRICT	**59,770 (3,358)**	**34.4 (1.93)**	**9.9 (0.72)**	**173,973**
BUFUMBIRA	59,770 (3,358)	34.4 (1.93)	9.9 (0.72)	173,973
MASINDI DISTRICT	**86,036 (3,886)**	**37.0 (1.67)**	**10.9 (0.73)**	**232,699**
BUJENJE	14,559 (773)	35.2 (1.87)	10.5 (0.87)	41,354
BULIISA	18,237 (899)	39.4 (1.94)	11.6 (0.83)	46,334
BURULI	24,042 (1,241)	33.3 (1.72)	9.6 (0.70)	72,146
KIBANDA	29,198 (1,443)	40.1 (1.98)	11.8 (0.85)	72,865
MBARARA DISTRICT	**124,892 (12,858)**	**23.4 (2.41)**	**6.2 (0.75)**	**533,524**
RWAMPARA	21,219 (2,403)	24.4 (2.76)	6.5 (0.87)	87,055
BUKANGA	11,125 (1,172)	20.9 (2.20)	5.4 (0.68)	53,273
IBANDA	29,903 (3,119)	23.1 (2.41)	6.1 (0.75)	129,418
ISINGIRO	24,631 (2,483)	23.1 (2.33)	6.1 (0.71)	106,563
KASHARI	12,378 (1,393)	24.3 (2.73)	6.4 (0.85)	51,039
KAZO	12,313 (1,286)	24.7 (2.58)	6.5 (0.80)	49,864
NYABUSHOZI	13,324 (1,425)	23.7 (2.53)	6.2 (0.79)	56,312
RUKUNGIRI DISTRICT	**102,972 (4,924)**	**30.1 (1.44)**	**8.2 (0.54)**	**341,933**
RUBABO	27,001 (1,372)	29.9 (1.52)	8.2 (0.55)	90,289
RUJUMBURA	32,822 (1,706)	30.2 (1.57)	8.3 (0.58)	108,639
KINKIIZI	43,149 (1,988)	30.2 (1.39)	8.3 (0.54)	143,005
Western Region	**1,124,892 (47,207)**	**33.6 (1.41)**	**9.6 (0.58)**	**3,348,005**

Standard errors in parentheses

Appendix D. Overlays of poverty, 1991 and 1999

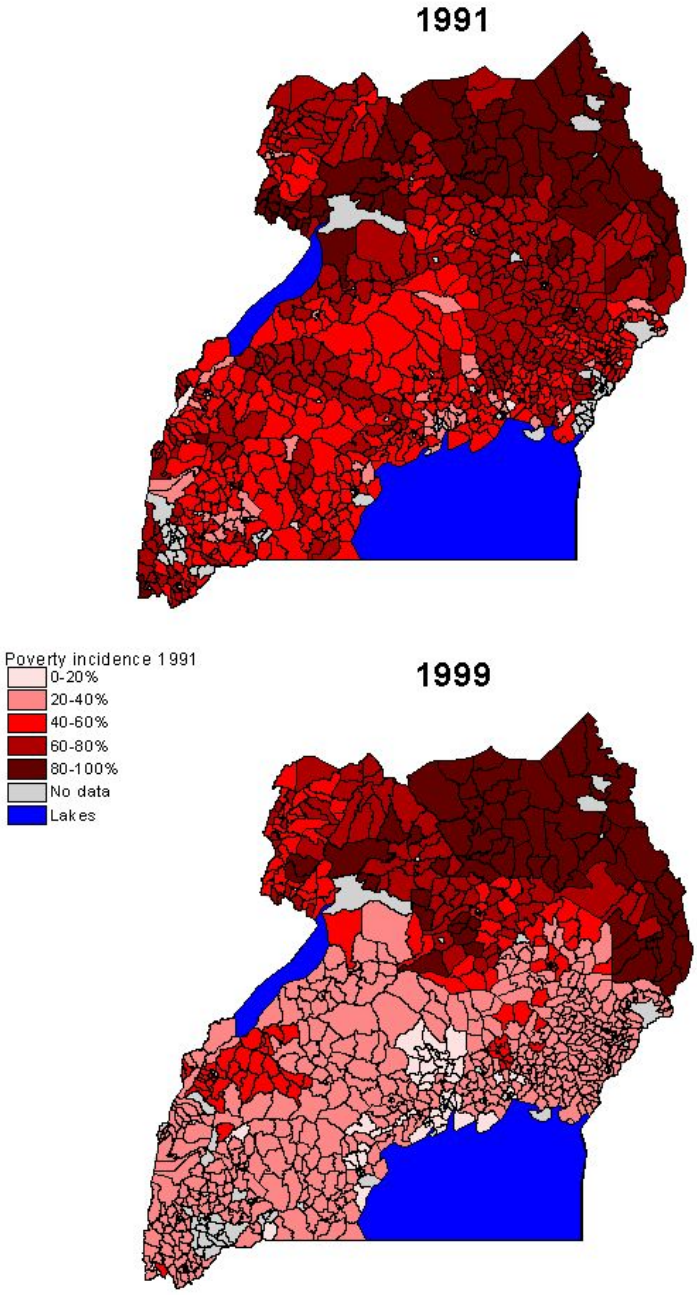

Figure D 1: Maps of poverty incidence in Uganda based on the poverty estimates with biomass, 1999 and 1999.