Natural resource collection work and children's schooling in Malawi

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Abstract

This paper presents results of research that investigates if long hours of work spent by children in fuel wood collection and water collection activities, hereafter referred to as resource (collection) work, are related to the probability that a child aged 6-14 will attend school. Possible endogeneity of resource work hours is corrected for, using two-stage conditional maximum likelihood estimation. Using data from a 1997-98 Malawi Integrated Household Survey (IHS) conducted by the National Statistics Office (NSO), the study finds that children are significantly involved in resource collection work and their probability of attending school decreases with increases in hours spent on this work. The study further shows that girls spend more hours on resource work and are more likely to be going to school while burdened by this work. Consequently, girls may find it difficult to progress well in school. However, girls are not necessarily less likely to be attending school. The results further show that presence of more women in a household is associated with a lower burden of resource work on children and a higher probability of children's school attendance while that of men is not. Finally, the study shows that children from the most environmentally degraded districts of central and southern Malawi are less likely to attend school and few of them have progressed to secondary school compared to those from the north region districts.

1.0 Introduction

The paper contributes to the population-environment-poverty debate by establishing the relationship between the environment and children's education. The study also contributes to the research gap that exists in the child labor literature that has concentrated more on the negative effects of formal child employment on schooling (Psacharopoulos 1997, Rosenzweig and Evenson, 1977). However, in sub-Saharan Africa, it is estimated that at least 95% of child labor takes place in private homes (Andvig 2000). Therefore, excluding the dimension of domestic child labor grossly underestimates the welfare impacts of work on children.

2.0 Background information

Malawi is a country of about 10 million people with a population density of 105 people per square km (NSO 2001). However, there are regional differences in population density. The south has 146 people per square km; the central region has 114 people, whereas the north has only 46 people per square km. In terms of fuel wood availability, the south and central regions are also the most distressed, with most of the districts estimated to be experiencing fuel wood shortages since 1985 (Figure 1). There are also significant education level differences between the north and the other regions. The north has a literacy rate of 72% while the central a 55% rate, and the south a 57% rate. This apparent negative "environmental degradation-education" relationship across the regions of Malawi was the motivation for this study.

Currently, 78% of Malawian children of primary-school age are enrolled in primary schools (NSO 2001). However, drop out rates are very high. Girls face special obstacles to education. For example, data from the Population Reference Bureau shows that only 12% of Malawian girls and 21% of boys are enrolled in secondary schools (PRB 2002). MoESC and DSPS (2000) also show that throughout the 1990's only about 25% of the Malawi University enrollments were girls.

Malawi also faces significant environmental problems. The deforestation is estimated at an annual rate of 2.4% between 1990 and 2000 (FAO 2001). Dependence of the population on fuel wood as a source of energy is one of the causes (Hudak and Wessman 2000). More than 90% of Malawians use firewood as their main source of energy for cooking (NSO 2000). About 85% of the Malawi population is rural and lives primarily on subsistence agriculture (NSO 2001). Therefore, a rapid depletion of natural resources such as forestland has significant consequences for the quality of people's lives. In terms of water access, the PRB reports that 57% of Malawians have access to an improved drinking water source (PRB 2002). The report also mentions Malawi as one of the 11 countries in Africa that by the year 2025 will join 14 other countries already experiencing a water scarcity crisis. The deforestation and water scarcity problems affect women and children in specific ways because they are primarily responsible for all domestic-related transport tasks. In Malawi it is estimated that women and children, especially girls, shoulder greater than 70% of the rural transport burden (Edmonds et al. 1995; PIRTP 1994). A large proportion of these tasks such as fuel wood collection and water collection are environmentally related. Therefore, environmental degradation can be expected to cause women and children to travel increasingly longer distances to access fuel wood and water sources.

The annual per capita income in Malawi is $170 (World Bank 2002) and it is estimated that 65.3% of the people lived below the poverty line in 1997-98 (NEC 2000). The poverty-environment hypothesis asserts that poor people tend to rely more on common property environmental resources than the non-poor (Jalal 1993). Therefore, the above situation makes Malawi to be a perfect case study for natural resource scarcity issues.

3.0 Theoretical Framework

The analysis is based on the household production/utility model of Becker (1965, 1993). The household maximizes utility subject to a set of constraints. The household utility is derived

from the household's consumption of home produced goods, the number of children, the

children's quality and the leisure enjoyed by household members. Optimal levels of consumption

goods, leisure, quality of children, and quantity of children depend on the shadow prices of these

goods as well as on the shadow price of total income. Quality of children can be measured by the

level of investment in children's education and/or their health, or by their education and health

attainment levels. *Increases* in time spent on fuel wood collection and water collection

(representing here a measure of environmental degradation) increase the cost of quality of children

because the mother may be time constrained and would benefit from the child's immediate help.

As a result, there is an incentive to reduce quality in favor of a greater quantity of children.

4.0 Data and Methods

The NSO 1997-98 IHS data from a national survey of 10,698 households, covering all

districts in Malawi, were used. The data provide demographic and socio-economic characteristics

of individuals and households, including child and adult levels of education. The data also provide

poverty binary variables constructed by the International Food Policy Research Institute (IFPRI),

Washington, D.C. and the Malawi National Economic Council (NEC). Details of how these

variables were constructed are described in NEC (2000). To capture the effect of environmental

stress on the probability of a child participating in resource work, median values of hours spent on

fuel wood collection and water collection were calculated for each of the 136 enumeration areas in

the data set. Each child was assigned the median value from the enumeration area where they live.

The median values are used as exogenous measures of fuel wood and water scarcity for a child in

that enumeration area. Cooke (2000) used a similar approach. If a child lives in an enumeration

area that has a median fuel wood collection time value greater than the total sample fuel wood

median variable value of 2.0, that child is assigned a "high fuel wood median time area" dummy

value equal to one. If a child lives in an enumeration area with median water collection time

greater than the total sample water median value of 3.0, the child is also assigned a "high water median time area" dummy value equal to one. The median times are calculated using the whole IHS sample of more than 15,000 individuals who reported domestic work hours. Household access to piped water inside or around the household home is also used as a measure of water scarcity. The piped water access dummy variable is interacted with rural and urban dummies to isolate other influences of urban/rural residence. Another way of capturing environmental degradation is through a fuel wood stock variable. This is done by constructing fuel wood scarcity district binary variables from the fuel wood availability map in Figure 1. The two districts estimated to have fuel wood surpluses in 2000 were labeled wood surplus districts, those that had fuel wood surpluses in 1985 but were estimated to have deficits in 2000 were coded as districts with moderate fuel wood deficits, while those that had deficits in 1985 and estimated to have deficits in 2000 were coded as districts with severe wood deficits. The districts with fuel wood surpluses are, therefore, used as the base category in the regressions. Other variables include child individual characteristics, household characteristics, and regional dummy variables.

The data are first used to descriptively show the relative contribution of children to domestic work. A series of models are then estimated to provide a better understanding of the interrelationships between resource scarcity and schooling. First, a bivariate probit model of the potentially joint decisions of resource work participation and school attendance is estimated. If the Rho coefficient (the correlation of the disturbances in the two probit equations) is statistically different from zero, this indicates that these decisions are jointly made. If not, univariate binary probit models can be estimated. In this case, the Rho coefficient of 0.073 was not statistically significant (p-value = 0.16), therefore, univariate probit models of resource work participation and school attendance were estimated and are presented here. In the school attendance probit, potential endogeneity of resource-work hours (intensity) was corrected following a two-stage conditional maximum likelihood (2SCML) estimation method developed by Rivers and Vuong

(1988) and as explained in Wooldridge (2002), since the *intensity* of resource work may still be endogenous. This involves estimating an OLS regression of resource hours and retaining the residuals, which are then included as one of the explanatory variables in the probit equation for school attendance, with the resource hours also included as an explanatory variable. This acts as a test as well as a correction for the endogeneity problem. If the t-statistic for the estimated coefficient of the residuals is statistically significant, this indicates that hours are endogenous in the school attendance probit.

A multinomial logit model of alternative work-schooling choices: doing resource-related work while attending school, attending school without doing resource work, or not attending school at all, was also estimated to check robustness of results. Finally, GIS analysis was used to show the relationship between fuel wood availability in Malawi and secondary school enrollments, at a regional level. The GIS analysis is a preliminary investigation of the relationship between environmental degradation and school performance.

5.0 Determinants of resource work participation and intensity

The descriptive statistics show that children aged 6-14 spend the most hours taking care of other children, followed by water collection, cooking, and fuel wood collection. The mean hours spent on domestic work are 18.3 hours per week. Comparing children's mean hours to the mean hours that all women aged 15 to 45 spend on the domestic activities shows that women rely heavily on children particularly for resource collection activities where, for example, children spend close to 70% of the time their "mothers" spend for water collection (Figure 2). Most of the domestic work is done by women and girls (Figure 3).

Results of the resource work and school attendance probit models, and the resource work hours' model are presented in Table 1. The results show that older children are more likely to do resource collection work (see column 2). The age at which participation in resource work peaks is

11 years. Older children also spend more hours on resource collection (see column 3). Girls are more likely than boys to do this kind of work, confirming the traditional division of labor typical of all sub-Saharan African countries. Girls also spend *longer hours* on resource work. The high fuel wood and water median time area variable coefficients are both positive showing that children who live in fuel wood or water distressed areas have a higher probability of being involved in resource work. The fuel wood scarcity variable is statistically significant while the water scarcity variable is only marginally statistically significant (p-value = 0.14). As expected, children in these areas also spend more hours on this work. Children who live in households that have access to own piped water are less likely to participate in (and to do more) resource work whether they live in urban or rural areas. The own piped water access dummy variables have the largest impact on probability of doing resource work. Unfortunately, less than 5% of the children have the privilege of having piped water in their home. Finally, children who live in districts with moderate or severe wood deficits spend more hours on resource work than those in the fuel wood surplus districts but they are not necessarily more likely to participate in this work.

Household characteristics and household composition variables also affect the likelihood of a child doing resource work. Poverty increases the likelihood of collecting natural resources as is expected from the poverty-environment hypothesis. The poor are also spending slightly more hours (0.4) on resource work. A child who lives in a female-headed household is also more likely to participate in resource work although not necessarily spending longer hours on this work. Presence of more infants (aged below one year) and children aged 1-5 years decrease the likelihood that a child aged 6-14 is involved in resource work. This may be due to other work responsibilities of childcare, cleaning, and cooking that young children impose on school-age children. Presence of more 1-5 year olds decreasing the hours of work on 6-14 year olds may also imply that there is significant help provided by the 4-5 year olds. Presence of young adult girls (aged 19-24) and women (aged 25-64) also decrease the likelihood that a child aged 6-14 is

involved in resource work. In terms of intensity of work, the presence of more children aged 1-5 years old, more boys aged 11-14, young adult girls aged 19-24, and women aged 25-64 decrease the hours of work that a child aged 6-14 spends on resource work. This suggests that presence of women and a larger number of household members in the non-school age range, except for boys aged 11-14, help to relieve the work burden on school-age children.

The regional differences in resource work participation and intensity may be reflecting availability of alternative sources of energy in the central and south, whether inferior or superior to fuel wood. Finally, children who live in urban areas, as expected, are less likely to participate in resource work and also spend fewer hours on this work than rural children.

5.1 Effects of resource work on school attendance

Results of a 2SCML model for school attendance are provided in Table 1 (see column 4). The wood and water scarcity dummy variables and the own piped water access dummy variables are used as instruments for resource work hours. The results show that older children are more likely to attend school up to the age of about 12 years, beyond which the likelihood of school attendance starts to decline. The female dummy variable coefficient is not statistically significant, implying that girls are not necessarily less likely to attend school.

The hours of work that children spend on resource work are associated with reduced likelihood of school attendance, supporting our hypothesis. The coefficient of the residuals from the resource work hours regression is not statistically significant (p-value = 0.19), indicating no or weak support for presence of endogeneity in school attendance and hours spent on resource-related work (Wooldridge 2002, p. 474). Formal child employment is the most significant determinant of school enrollment, but this affects only 3.5% of the children. Children in districts with severe fuel wood deficits are also less likely to attend school. When the fuel wood deficit district dummy variables are excluded from the model, the south and central districts have

statistically significant negative marginal effects on school attendance, implying that other aspects of environmental degradation may be the reason for the low primary school attendance observed in south and central regions relative to the north region.

Poverty is another constraint on the education of children but increased education of the household head increases school attendance. The presence of more young girls (6-10 years old) and women in all age categories, also increase children's schooling. This likely suggests that it is the female members of the household that are mostly involved in household responsibilities, thereby reducing the burden of household work from school-age children. This suggests that education of children may be enhanced even through "non-monetary" adjustments, such as, encouraging men's involvement in domestic work. Presence of more infants is associated with lower children's school attendance while presence of more children aged 1 to 5 years is not statistically significant. This is likely due to the increased financial demands that infants place on households relative to toddlers. However, regressions of total domestic work hours (not reported) show that both infants and children aged 1 to 5 increase the work burden on children aged 6-14.

Children who live in urban areas are not necessarily more likely to attend school. However, rural/urban differences are more likely to exist with regard to performance indicators. This is supported by multinomial logit regression results (Table 2), showing that urban children are less likely to combine schooling with resource work but are more likely to attend school without doing this work. Most of the results from the probit regressions are also supported. For example, girls are not necessarily less likely to be attending school. However, the girls are more likely to be combining schooling with fuel wood and/or water collection but are *less likely* to be attending school without doing these tasks. This result suggests that parents do not consciously discriminate between girls and boys when it comes to school enrollment but that girls have the extra burden of doing domestic work. Consequently, the girls may find it difficult to progress well in school. The multinomial logit results also show that children who live in districts with severe wood deficits are

more likely not to attend school. In this regression, unlike in the probit model, the south and central dummy variables are negative and significant in the no schooling option, although they are expected to be insignificant after controlling for wood scarcity variables.

Figure 4 is a mapping of boys' and girls' secondary school enrollments and the fuel wood scarcity index at a regional level. The figure shows that children in the least degraded northern region are one and a half times more likely to proceed to secondary school than those in the south and central regions of Malawi. This suggests that it is not only primary school enrollment that is related to environmental degradation but primary school performance and, hence, secondary school enrollment as well. School performance in relation to environmental degradation in Malawi was analyzed in another paper by Nankhuni and Findies (2003).

6.0 Conclusions

Results of this analysis support the hypothesis of a negative relationship between environmental degradation and the education status of children. This means that by increasing children's work, environmental degradation may well contribute to the low education of children in Malawi. The lower likelihood of school attendance with increased hours of work shows that parents trade-off investment in children's education in favor of using children for labor. The presence of more women being associated with decreased work on children and increased school attendance implies that education of children can be enhanced even through "non-monetary" adjustments such as a change in cultural attitudes towards encouraging men's involvement in domestic work. On the other hand, the relationships between the environment and children's schooling suggest that there exist opportunities to integrate environment programs with development initiatives in the field of education. For example, an environmental program to reforest the degraded areas in Malawi can also be combined with a primary-school scholarship program to help ameliorate the negative effects of deforestation on education.

Table 1: Estimated models of resource work and school attendance participation.

Variable	Resource work participation	Resource work hours	School Participation	Mean
Constant	0.014	4.919***	-0.738***	-
Age	0.045***	0.278***	0.166***	11.032
Age squared	-0.002***	-	-0.007***	129.421
Female	0.127***	2.475***	0.016	0.662
Biological child	0.000	-0.001	0.016	0.773
Child employment	0.021	-0.498	-0.834***	0.035
Resource work time	-	-	-0.006*	6.474
Residuals	-	-	0.004	0.000
High fuel wood median time area	0.030***	1.801***	-	0.348
High water median time area	0.012	1.014***	-	0.564
District with moderate wood deficits	-0.135*	2.716***	-0.044	0.090
District with severe wood deficits	-0.061***	4.447***	-0.077***	0.862
Urban with own piped water	-0.296***	-1.291**	-	0.047
Rural with own piped water	-0.260***	-4.973***	-	0.015
Household poverty	0.030***	0.397*	-0.025***	0.696
Female headship	0.022*	0.643	0.016	0.284
Standard 4 head	-	-	0.020**	0.232
Standard 8 head	-	-	0.069***	0.349
Highly educated head	-	-	0.072***	0.142
Infants	-0.019**	0.370	-0.028***	0.124
Girls 1-5 yrs	-0.030***	-0.454***	-0.003	0.393
Boys 1-5 yrs	-0.039***	-0.331**	0.002	0.365
Girls 6-10 yrs	0.006	0.204	0.013*	0.706
Boys 6-10 yrs	0.004	-0.009	0.004	0.600
Girls 11-14 yrs	-0.008	0.076	0.001	0.614
Boys 11-14 yrs	-0.009	-0.345*	0.002	0.443
Girls 15-18 yrs	0.003	-0.019	0.012	0.312
Boys 15-18 yrs	0.004	-0.183	0.005	0.344
Young adult girls 19-24 yrs	-0.046**	-1.306***	0.027*	0.152
Young adult boys 19-24 yrs	0.008	0.401*	0.009	0.189
Women 25-64 yrs	-0.017*	-1.012***	0.043***	0.907
Men 25-64 yrs	0.008	0.216	0.011	0.708
Old women =65 yrs	0.022	-0.669	0.038*	0.066
Old men =65 yrs	0.014	-0.049	0.000	0.056
South region	-0.066*	-6.233***	0.029	0.362
Central region	-0.057*	-8.866***	0.024	0.564
Urban	-0.107***	-2.061***	0.022	0.122

Columns 2 and 4 report the marginal effects, column 3 reports OLS regression coefficients.

Number of observations in model in column 2 is 4778, of which 88.1% participated in resource work.

Number of observations in model in column 3 is 4778.

Number of observations in model in column 4 is 4742, of which 86.2% attended school.

*** means the variable coefficient is significant at 1% level of significance, ** means it is significant at 5% level of significance and * means the variable coefficient is significant at 10% level of significance.

Table 2: Multinomial logit regression showing the marginal effects of variables on probability, N=4777.

| Variable	Combining resource work and schooling (76.3%)	Schooling without involving in resource work (10.0%)	No schooling (13.7%)
Constant	-0.643***	-0.102*	0.745***
Age	0.168***	-0.016*	-0.152***
Age squared	-0.007***	0.001	0.006***
Female	0.083***	-0.078***	-0.005
Biological child	-0.006	0.014	-0.008
Child employment	-0.300***	-0.103*	0.403***
District with moderate wood deficits	-0.078	0.026	0.052
District with severe wood deficits	-0.138***	0.015	0.123***
Urban with own piped water	-0.111***	0.112***	-0.002
Household poverty	0.005	-0.031***	0.026***
Standard 4 head	0.032**	-0.011	-0.021**
Standard 8 head	0.088***	-0.016**	-0.072***
Highly educated head	0.075***	0.012	-0.087***
Infants	-0.046***	0.015*	0.031***
Girls 1-5 yrs	-0.026***	0.025***	0.001
Boys 1-5 yrs	-0.033***	0.034***	-0.001
Girls 6-10 yrs	0.014*	-0.002	-0.012*
Boys 6-10 yrs	0.007	-0.003	-0.004
Girls 11-14 yrs	-0.006	0.005	0.001
Boys 11-14 yrs	-0.002	0.005	-0.003
Girls 15-18 yrs	0.016	-0.005	-0.011
Boys 15-18 yrs	0.010	-0.003	-0.007
Young adult girls 19-24 yrs	-0.002	0.035***	-0.033**
Young adult boys 19-24 yrs	0.007	-0.001	-0.006
Women 25-64 yrs	0.037***	0.014*	-0.051***
Men 25-64 yrs	-0.003	0.006	-0.003
Old women ≥ 65 yrs	0.054**	-0.016	-0.038**
Old men ≥ 65 yrs	-0.003	-0.004	0.008
South region	0.001	0.069**	-0.070**
Central region	0.007	0.069**	-0.076**
Urban	-0.034	0.055***	-0.022

*** means the variable coefficient is significant at 1% level of significance.

** means the variable coefficient is significant at 5% level of significance.

* means the variable coefficient is significant at 10% level of significance.

( ) percent that participated.

Figure 1: Fuel wood availability in Malawi
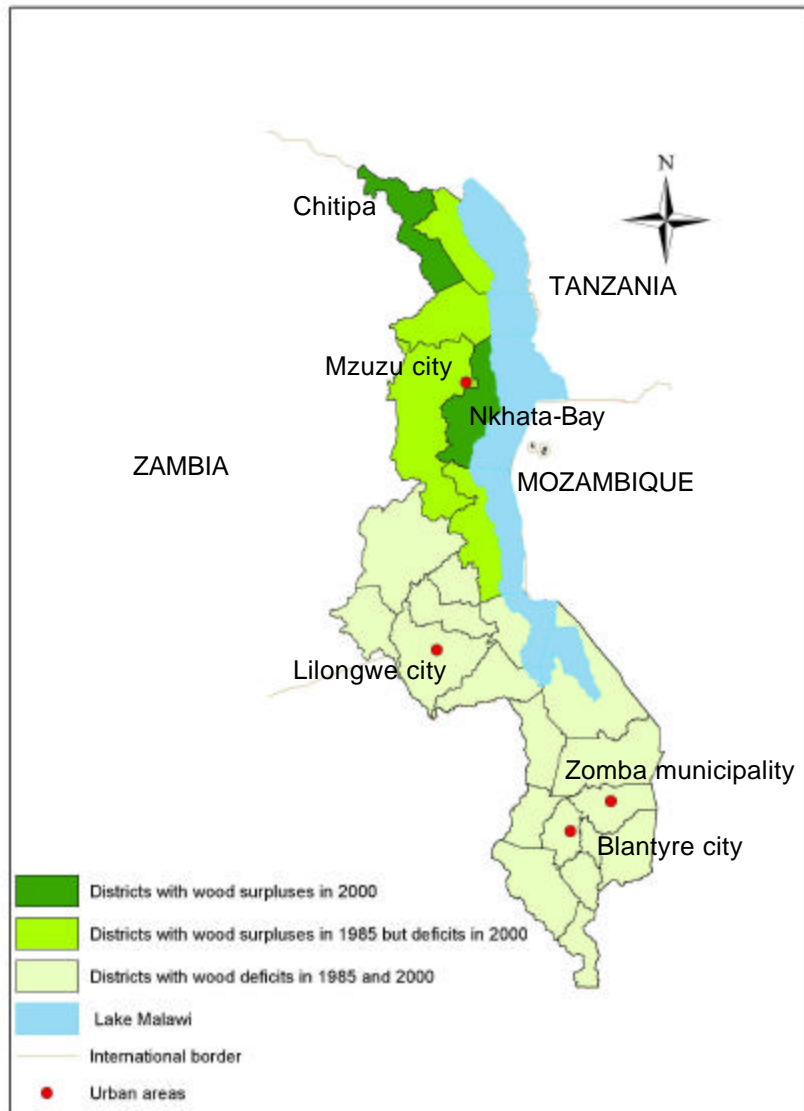
Data Source: National Physical Development Plan Study, OPC, Town and Country Planning Department, Lilongwe, Malawi (GOM 1987).
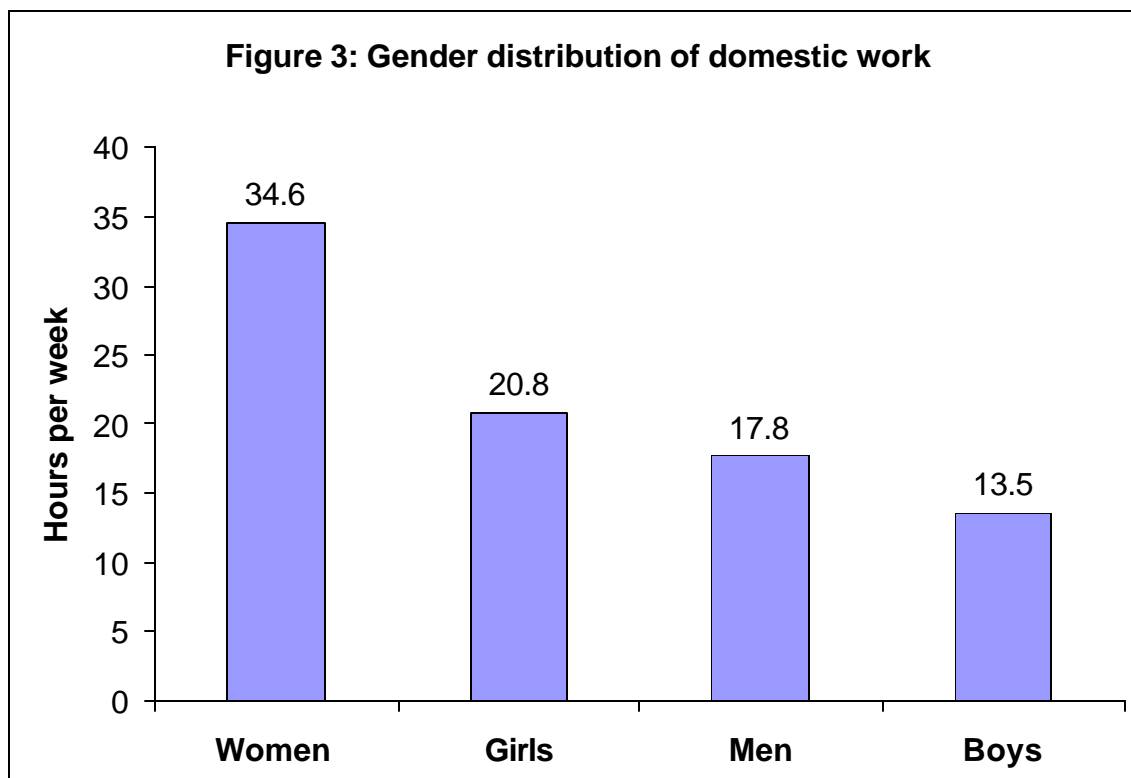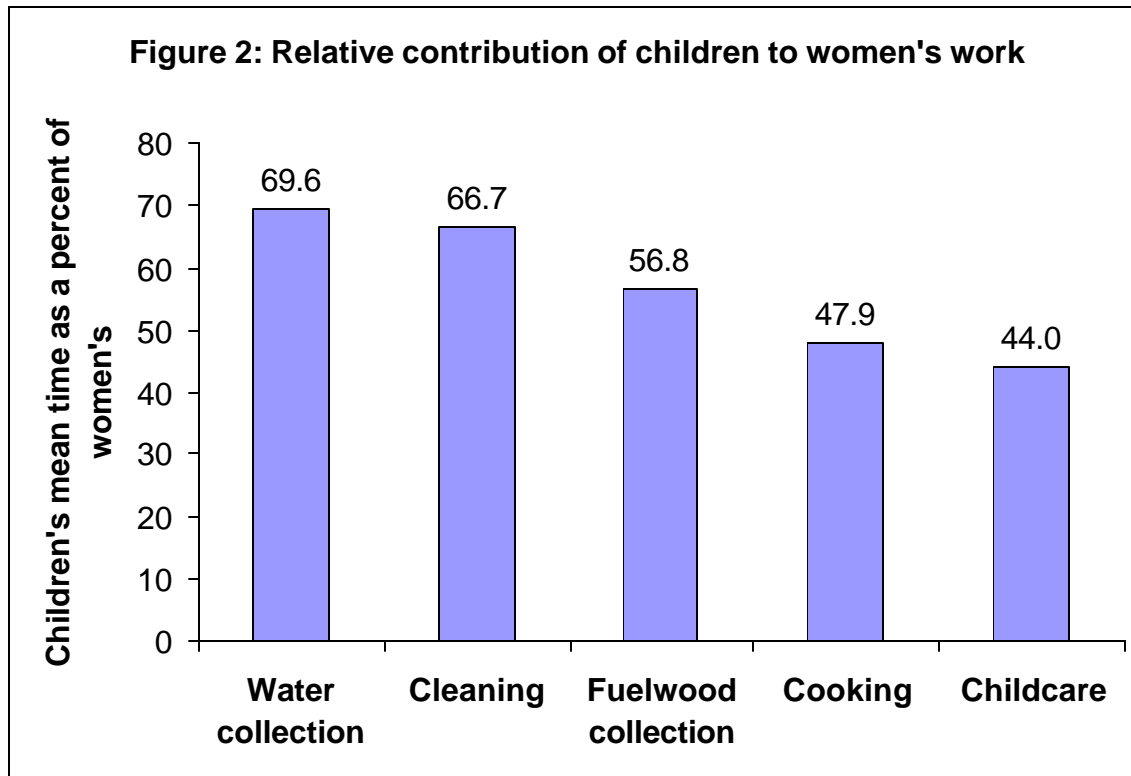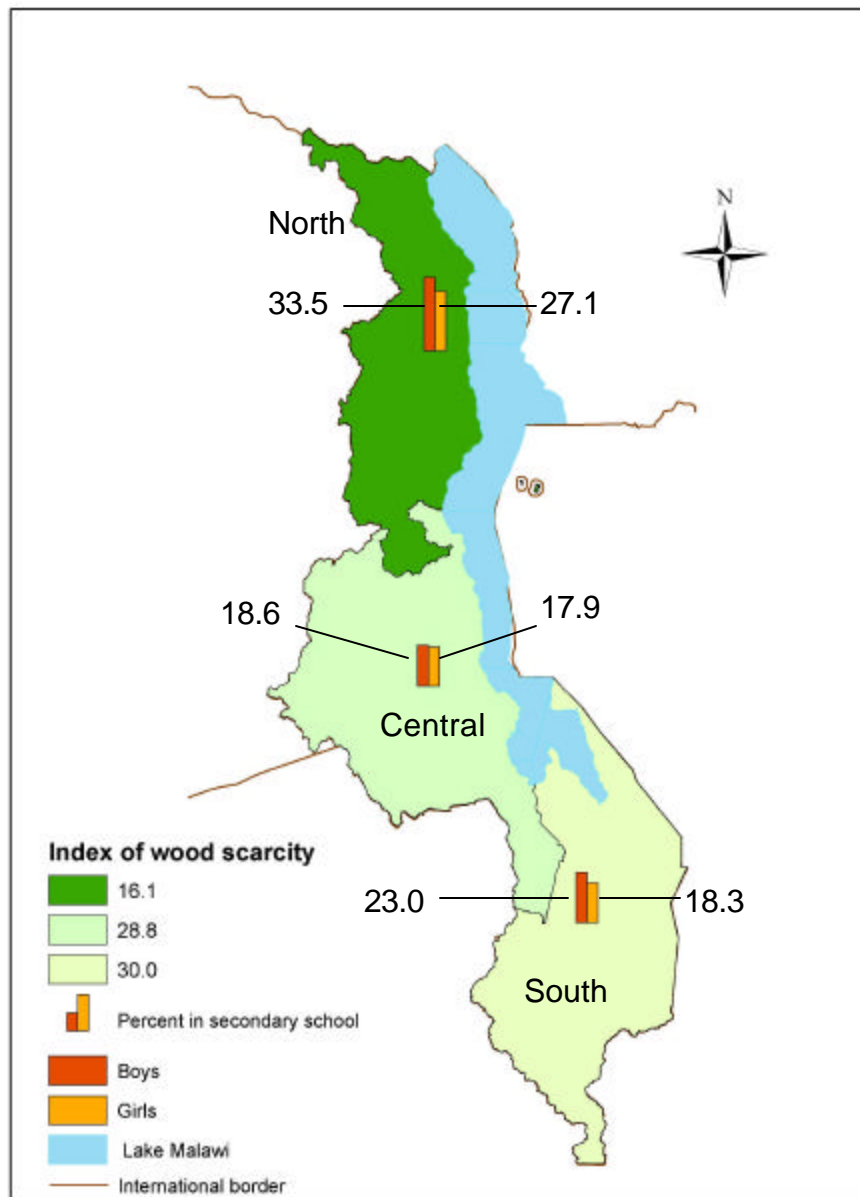
Figure 2: Relative contribution of children to women's work

Children's mean time as a percent of women's

Water collection	69.6
Cleaning	66.7
Fuelwood collection	56.8
Cooking	47.9
Childcare	44.0

Figure 3: Gender distribution of domestic work

Hours per week

Women	34.6
Girls	20.8
Men	17.8
Boys	13.5

**Figure 4: Fuel wood scarcity and secondary
school enrollment in regions of Malawi**

Data source: OPC (Figure1) and survey data (IHS 1997-98)

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