Environmental Goods collection and Children's Schooling: Evidence from Kenya.

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Abstract

This study examines the link between environmental goods collection and children schooling in Kiambu District, Kenya. The study was carried out against the increasing consensus in the literature on household dependence on natural resources and the suggested consequences on households investing more time in collection of those scarce resources especially firewood and water. Children schooling is measured as the child's school attendance and performance in school. Our study uses data collected from 200 households using a detailed questionnaire. The sample had 609 children from Lari, Ndeiya and Kikuyu Divisions of Kiambu District. The descriptive statistics indicates that children are involved in both decisions of resource collection and school attendance. Since the two decisions are jointly determined we first estimate the bivariate probit model. In addition, possible endogeneity of resource collection work in the school attendance equation is corrected for, using instrumental variable Probit estimation. The probit model was also estimated for the performance model. The results support the hypothesis of a negative relationship between children resource collection work and their likelihood of attending school. The results also suggest that performance in school does not depend on environmental goods/resource collection work of children. Finally the study recommends ways of increasing water supply to reduce the time children spend on collecting it and ways of substituting firewood.

Key words: Kenya, firewood, water, children, education

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1.0 Introduction

The inter-linkage of population, environment and poverty has been a debatable issue and concern to policy makers for decades. However, the link between poverty, population, degradation of natural resources in many countries is not well understood. Since the environment is important to people entrapped in poverty, the survival of the poor is often anchored to a wide range of natural resources and ecosystem services[1] for their livelihoods. Specifically, the rural poor people are particularly concerned with secure access to and the quality of natural resources, such as arable land and water, crop and livestock diversity, forest products and biomass for fuel (DFID 2002).

In this regard, one might inquire if there is scarcity of firewood, where it is collected from and who collects it. Appropriate response to this issue is based on given options for households on where to get the resources, depending on their income levels, asset base and the local resource base to obtain the resources. Dominant component of common property resource literature significantly claims that since poor people are more dependent on natural resources than non-poor households, they consequently derive higher economic benefits from the local commons (Dasgupta and Mäler 2004).

Most literature on the interaction regarding population, the environment, and poverty tend to indicate that population growth is a major cause of environmental degradation (Malthus 1798, Boserup 1965, Nerlove 1991, Hardin 1968, Dasgupta 2000). However, some studies have quantified the reverse impact, and indicated that the environment may affect demographic behaviours. This is evidenced in Nepal, Malawi and Pakistan (Filmer and Pritchett 1996, 1997, Cooke 2000, Nankhuni and Findeis, 2003). The literature further shows that there is significant evidence on household involvement in resource collection especially in Asia (Kumar and Hotchkiss 1988, Filmer and Pritchett 1996, 1997, 2002, Cooke 1998, 2000). Children are significantly involved in helping their parents in various activities (Nankhuni and Findeis 2003, Filmer and Pritchett 2002). Nerlove (1991) argued that children have comparative advantage in household tasks compared to adults. Environmental degradation is associated with poor water quality and

[1] The ecosystem services enjoyed by humans include provision services, regulating services, cultural services and supporting services. In this study we shall focus on provision of services such as water and fuels. (see WRI 2007 pp. 4)

scarcity and firewood scarcity which are environmental parameters in those studies. The study by Nankhuni and Findeis (2003) established that environmental degradation negatively affects schooling of children in Malawi; however, this is the only study in Africa on effects of environment and schooling we have identified. Hence there is need for more studies on this pertinent issue in Africa.

The labour and school outcomes of children have received increasing attention recently, especially with the emergence of the problem of child labour. In the empirical literature on child labour and schooling, there is a tendency to narrow the discussion and analysis of the determinants of children's activities to market labour and schooling (Rosenzweig and Evenson 1977, Basu 1999, Fares and Dhushyanth 2007). However, Ilahi (2001) looks at gender dimension of child time use with focus on domestic child labour. Indeed domestic work constitutes a large part of children's work which may have a negative impact on child school attendance and performance.

This study is motivated by the decline in firewood availability in rural areas in Kenya and water scarcity which demands collection activities by household members. Given the increasing pressure on biomass resources in many rural areas in Kenya and the common gender division of collection labour, there is concern that women and children in particular will bear the burden due to increased resource scarcity by having to spend more labour time and effort to collect environmental goods. These resource collection pressures have negative effects on children schooling which is the key results of this study. Using deforestation and water scarcity as examples of environmental degradation the study attempts to shed light on the linkage between resource collection activities and schooling. Accordingly, this study contributes to the issues relating to resource scarcity, resource collection and their effects on child schooling in Kenya.

The rest of the paper is structured as follows: Section 2 highlights the background information; section 3 contains the empirical strategy with the model and explanation of the data source and sampling procedures; Section 4 reports the study results; section 5 concludes.

2.0 Background information

The total land surface in Kenya is 576,000km^2 which is used for agriculture and livestock. However there have been increased human processes in Kenya leading to land degradation, (GoK 2003). Forest cover is also a major resource in Kenya especially for firewood, timber, among many other uses. In the rural areas, the main fuels consumed are wood, charcoal and crop residues, 84 per cent of the population do not have access to electricity while firewood which is becoming increasingly scarce as forest area declines accounts for about 70 per cent of all energy consumed in Kenya, but firewood, (UNEP 2005).

The state of environment report in Kenya, (GoK 2003) shows that households in rural areas of Kenya often rely profoundly on the natural resources such as land, water, forests for firewood which accounts for over 75 per cent of their cooking energy, and fodder for livestock. These resources have been declining due to population pressure, deforestation and climatic conditions making them scarce. As population increases, firewood consumption are expected to increase, further constraining fuel supply. This increase in firewood demand negatively impacts on biodiversity and other provisioning services that forests provide. Often, these environmental goods are collected from neighbouring forest, this leads to serious deforestation both for fuel and cultivation land. This is the major cause of firewood scarcity in the rural areas in Kenya, (GoK 2003).

There has been wanton deforestation in catchments areas of Mt. Kenya, Upland forest in Lari Division, Mau Forest, Aberdare and Mt. Elgon. Deforestation is largely being caused by firewood demand for tea processing, timber for domestic and export markets, agricultural production, among others. Households also use crop residue as a supplementary energy source. The use of crop residue as a fuel source is however, entirely dependent on the availability of firewood and the size of the harvests. The decline in agricultural and livestock productivity imply similar circumstances for the supply of dung and crop residue, (UNEP 2005).

The other scarce resource in rural areas is water. Agriculture accounts for the largest withdrawals of water in Kenya. Due to inconsistent and poor distribution of water, 50 per cent of Kenyan households do not have access to safe drinking water, (UNEP 2005).

The rapid depletion of natural resources can have significant consequences on the quality of the lives of rural women and children who are primarily responsible for collection of firewood and water.

Child labour indicator in general include: schooling status, status in employment and hours of work. Children in the school going age who did not attend school during the school year but were reported to have worked are, therefore, considered to have been engaged in child labour. This also applies to work by children who did not proceed to secondary school after completing the primary school. Going by schooling indicator, it can be stated that child labour in Kenya stood at 1.3 million children by the year 1999, (CBS 2003). The labour force survey 1998/99 has indicated that a large number of schooling children (58.2 percent) worked for more than 25 hours in a week (CBS 2003). This is equivalent to more than 4 hours a day in a 6 day working week. Their academic performances are likely to be adversely affected since some of the tasks they performed were quite demanding in terms of physical effort and time. The survey revealed that 1.3 million working children aged between 5 to 17 years were out of school. This is likely to have affected the development of their knowledge base necessary for normal life. In addition, it found out that 18.4 percent of the working children who were out of school had no formal education.

3.0 The Empirical strategy

Both theoretical and empirical work on time allocation traces its roots to Becker (1965), who first formulated a utility-maximizing model of *Z* goods which were produced by both time and market goods inputs. This model has been widely used to analyze choices of hours worked and later extended by Gronau (1977) to include home production and leisure. Recent empirical work on time allocation in developing countries, have taken the work of Becker (1965), Gronau (1977) and Singh *et al*., (1986) as a starting point, however they had to deal with the realities of home production and household structure in these countries (see for instance Rosenzweig and Evenson (1977)). The model by Rosenzweig and Evenson (1977) which capture time allocation aspect, in the context of developing country will be adopted in this study. This model has also been applied by

Nankhuni and Findeis (2003) in studying resource collection and schooling in Malawi. In this model parents maximize a utility function subject to a set of constraints.

3.1 Model Specification

The decision to participate in resource collection and school attendance are jointly determined. This calls for the estimation of a simultaneous equations model for binary variables. Following Greene (1998), Greene (2003) and Nankhuni & Findeis (2003) we adopt the following bivariate probit model.

$$\eta_{i1} = x'_{i1}\beta_1 + \varepsilon_{i1}, y_{i1} = 1 \text{ if } \eta_{i1} > 0 \;\; y_{i1} = 0 \text{ otherwise} \quad (1)$$

$$\eta_{i2} = x'_{i2}\beta_2 + \varepsilon_{i2}, y_{i2} = 1 \text{ if } \eta_{i2} > 0, \; y_{i2} = 0 \text{ otherwise} \quad (2)$$

$[\varepsilon_{i1}, \varepsilon_{i2}, \rho]$ ~ Bivariate normal (BVN)

Where individual observations on y_1 and y_2 are available for all i, the y_{i1} and y_{i2} are the choices of school attendance and participation in resource collection work observed in the data, respectively; η_{i1} and η_{i2} are the latent variables from which the decisions to participate in these two choices are defined; X_1 and X_2 are the independent variables (household characteristics, environmental variables, demographic variables and child characteristic variables) in the school attendance model and the resource collection work model respectively; and ε_{i1} and ε_{i2} are the error terms which may be correlated.

Given the relationship between school attendance and resource collection there are reasons to suspect the recursive simultaneous equation model. School attendance may be affected by the amount of time that a child spends on resource collection. Therefore, school attendance may be sensitive to the time that a child spends collecting firewood or water. Hence, we treat the participation of children in resource collection work as an endogenous explanatory variable in the schooling equation.

$$y_1 = X_{i1}\beta_{i1} + \tau y_2 + \varepsilon_1 \quad (3)$$

$$y_2 = X_{i2}\beta_{i2} + \varepsilon_2 \quad (4)$$

In this model interdependence arises between y_1(school attendance) and y_2(participation in resource collection work), because y_2 appears in the right hand side of equation (3). Rivers and Vuong (1988) propose a two-stage estimation procedure to

correct for endogeneity. To motivate the need for use of instrumental variables, we consider the following structural form equation for schooling and reduced form equation for resource collection.

$$y_1 = \beta x_i + \tau y_2 + \varepsilon_1 \quad (5)$$

$$y_2 = \alpha x_i + \delta z + \varepsilon_2 \quad (6)$$

Where, the structural equation of school attendance, variable y_1 is given by equation 5, while the reduced form equation of the resource participation, variable y_2 is given by equation 6. The instrumental variables (z) such as distance to the source of resource or the time taken to the source are included in the reduced form equation but excluded from the structural form. The common exogenous covariates which belong in both equations are given by the vector **X**.

The critical question is whether each equation in the system is identified. The first challenge in estimating the causal impact of resource collection on education outcome is the possibility of unobserved characteristics of households which influence their decision to collect resources also playing a role in their schooling decisions. For example, parents who care more strongly about the education of their children may not engage their children in intensive resource collection activities despite the fact that there is resource scarcity. Moreover a household that has many children who are out of school may reduce the burden of resource collection for those who are in school.

The arising problem is isolating the effect of participation in resource collection activities on the school attendance and academic performance of the children. This problem has been solved by using variable z as an instrument for y_2 (resource collection activity). An instrumental variable estimation relies on the exogenous assumption, that z is exogenous and valid. Rivers and Vuong (1988) proposed a two-step Conditional Maximum Likelihood (2SCML). Following 2SCML, an OLS regression of resource collection work is estimated, in the first stage. Residuals from the stage 1 regression are then retained. In the second stage, a probit model of school attendance is estimated, with resource collection work and the residuals from the OLS regression included among the explanatory variables. If the estimated coefficient of the residuals is statistically significant, this indicates that the resource collection minutes are endogenous in the

school attendance probit. This can be done directly by the instrumental variables probit (IV-Probit) in Stata.

3.2 Data

We relied mainly on primary data collected from a cross-section of 200 rural households in Kiambu[2] rural areas using structured questionnaires. A detailed questionnaire was used to collect the basic data and probed the socio-economic characteristics of households, economic activities, collection activities and children schooling details. This study was limited to Lari, Kikuyu and Ndeiya Divisions in Kiambu District which have continued to experience increased incidences of poverty and environmental degradation. The main reason for selecting this district is due to the continued deforestation of the upland forest which has brought the firewood and water scarcity problems in the district especially Lari division and some parts of Kikuyu Division. Ndeiya Division and Karai Location in Kikuyu Division have low agricultural potential compared to other parts of the District.

Kiambu District only contributes 1.48 per cent to the national poverty. However, in Lari Division 30 per cent of the population lives below the poverty line while in Ndeiya Division it is estimated that 60 per cent of the population is poor. Indeed in the dry season, the nearest potable water point is on average 7 km in Ndeiya division. Child labour is also a severe problem in the district, since children between the schooling ages between 10 to 18 years are estimated to be working children in the agricultural related activities and other household chores, (GoK, 2002).

Sampling procedures

Data was collected from a sample of 200 households drawn from 20 villages where 9 are from Lari division, 6 from Kikuyu division and 5 from Ndeiya division (targeting households living near uplands and Nyandarua forests in Lari Division while those from Ndeiya Division and Karai Location in Kikuyu Division experience the same agro

[2] Kiambu is one of the seven districts in the Central Province of Kenya by the year 2002. It is located in the south of the province and has a total area of 1,323.9 km^2 with the population of 802,625,000 persons as per the 1999 census; with a projected growth rate of 2.56 per cent per annum. Kiambu borders Nairobi City and Kajiado District to the south, Nyandarua to the northwest, Nakuru District to the west and Thika district to the east. Kiambu District is divided into seven administrative Divisions namely Kiambaa, Githunguri, Limuru, Kikuyu, Ndeiya, Lari and Kiambu Municipality. Lari Division is the largest with a spatial area of 441.1 km^2 while Kiambaa is the smallest division with an area of 91.1 km^2, (GoK, 2002).

ecological conditions) in April and May 2007. Purposive sampling methods were used to select the divisions and locations of study, owing to the presence of the characteristics of interest and taking into account the scope of the study, time and financial considerations. The study sample was generated using the sampling framework provided by the Kenya National Bureau of Statistics. To ensure equal representation, all the three divisions were sampled using the proportion of Enumeration Areas (EAs) created for the 1999 Census. Multistage sampling was then used to select the sample, namely sub-location, villages (EAs) and households. In the first stage the three divisions were selected namely Kikuyu Lari and Ndeiya. Following the EAs information the study proportionately sampled 9 EAs out of 102 EAs, 6 EAs out of 68 EAs and 5 EAs out of 47 EAs from Lari division, Kikuyu division and Ndeiya Division respectively. A total of 20 villages were systematically sampled translating into a village from each sub-location. Then 10 households were randomly selected from each village. This translated to a sample size of a total of 200 households or 90 households, 60 households, 50 households from Lari, Kikuyu and Ndeiya respectively.

4.0 Results

We discuss the results under two sub sections. First, we present the descriptive statistics followed by the econometrics estimations.

4.1 Descriptive statistics

The social-economic characteristics of the 200 sampled households are presented in Table 1. The data display low female headed households, at 13 percent of all households in the sample. The results indicate low average terminal level of education of household head with years of schooling, suggesting an average of primary education for most of household heads (8 years of schooling). This is also supportive of the education attainment dummies which indicate that only 38 per cent of all household heads had completed post primary education compared to 60 per cent who had completed primary education.

Table 1; Social economic characteristics of the 200 households sampled

variable	Mean	Std. Dev	Min	max
Male head	0.87	0.337	0	1
Age of head	42.475	9.49	22	83
Head years of schooling	8.675	2.81	0	16
No education	0.02	0.12	0	1
Primary education	0.60	0.49	0	1
Post primary education	0.38	0.48	0	1
Household size	6.16	1.54	3	11
Number of children	4.10	1.59	0	9
Children age < 6 years	0.12	0.32	0	1
Children age 6 to 14 years	0.33	0.47	0	1
Children age 15 to 18 years	0.12	0.32	0	1
19 to 24 years adults	0.08	0.27	0	1
Over 25 years	0.35	0.48	0	1

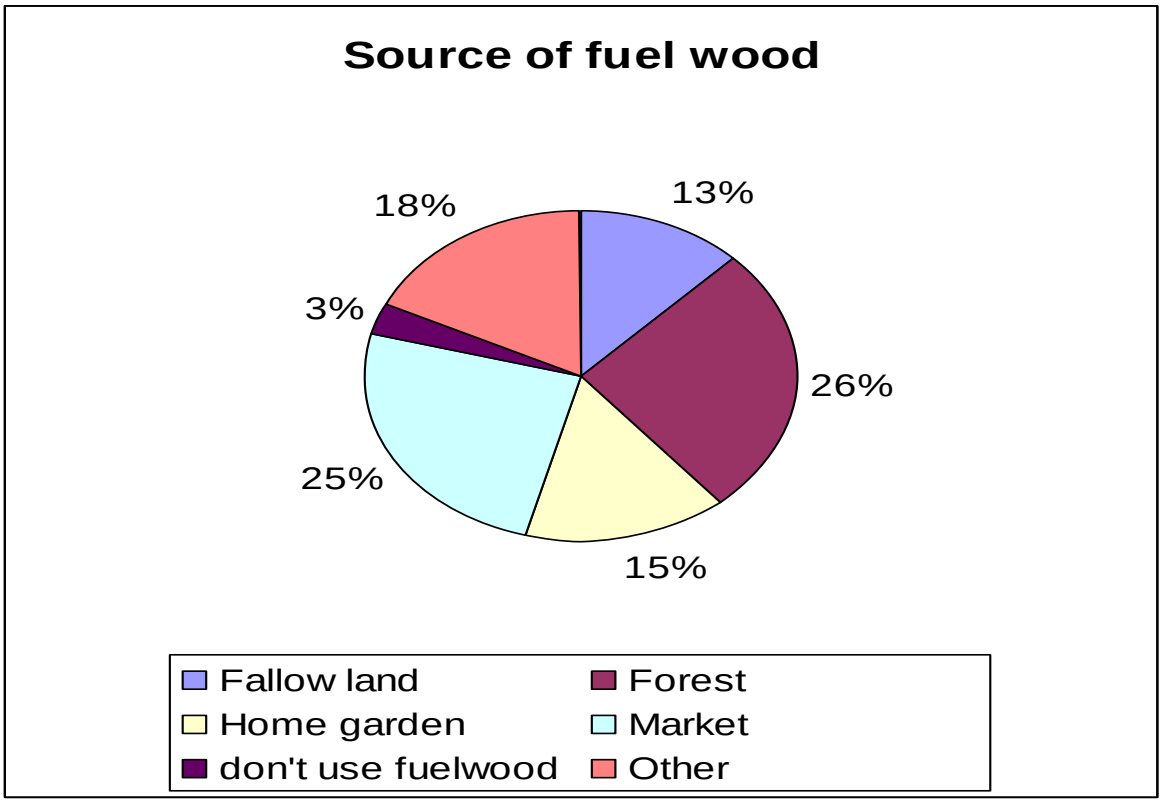
Source: Field survey data 2007

The age categorization indicates that 45 per cent of the sampled age groups are school going children (age 6 to 18 years) who will be considered for the schooling models. Moreover, the household size on average is six members with an average of four children indicating that households with more children who are out of school are likely to participate in resource collection reducing the burden of resource collection to those school going children.

Firewood collection data

Households were asked questions on where they collect firewood and their responses are reported in the figure 1 below.

Figure 1: Sources of firewood for households



Source: Field survey data 2007

The statistics reveal that around 25 per cent of sampled household obtain firewood from the market while another around 18 per cent combine buying firewood and collection from commons. These clearly indicate that there is a well defined market of firewood in the sampled areas of Kiambu District. The prices of firewood vary depending on the source of firewood and the perceived scarcity by the dwellers. For instance firewood prices from Karai were collected from the major distributor of firewood who has a well organized firewood business. In Ndeiya Division firewood is bought from households who collect firewood for selling purposes and they either take the firewood to their customers or in some cases the customers buy the firewood from their homes**.**

In Lari division, where 48 per cent collect firewood from the forest, they pay a monthly fee of Ksh. 45 to the forest department, which is meant for any firewood collection by hand or body once a day from the forest. However, this monthly rental rate is quite low and it can not be used as a proxy for resource scarcity as discussed by Gardner and Barry (1978), when they were exploring the alternative measures of natural resource scarcity.

Those who collect firewood for sale usually collect on average 57 pieces of approximately 1 meter long bamboo tree which is sold at an average cost of Kshs. 135.

Table 2: Mean time taken by households' member to source of firewood in minutes

Source	Karai	Lari	Ndeiya
Fallow land	228.75	240	168.57
Forest	254	269.5	195
Home garden	57.27	102.92	80.18
Market	25.26	27	28.22

Source: Field survey data 2007

Another measure of resource scarcity is time per trip as suggested by Filmer and Pritchett (1996); Households were asked if they had a problem of supply of firewood which would normally be indicated by travel time and distance to source of firewood. The average time of a two way trip plus collection time to collect firewood depends on the source of the firewood with firewood from the forest taking the highest number of minutes, with the market taking the least time. Average collection and travel time two way to collect firewood in the forest is 257.85 minutes, ranging from a minimum of 30 minutes to 600 minutes and an average distance of around 3 km. This varies from 0 km to 10 km. with Lari division having the highest collection time as shown in Table 2.

Market for firewood

Those who collect firewood from the market buy it from dealers who operate a firewood business with various firewood pieces with a different price tag. Table 2 shows the different pieces and their prices per piece.

Table 3: firewood price per cubic Metre

Price per piece of wood	Volume of a firewood piece in cubic Metres
Ksh 1.50 piece	0.0029
Ksh 2 piece	0.0035
Ksh 2.50 piece	0.0042
Ksh 3 piece	0.0048
Ksh 5 piece	0.0064
Ksh 7 piece	0.0096

Source: Field survey data 2007

The table indicates that the price of firewood varies considerably with the different volumes of firewood pieces that customers select from the categories of firewood provided by the firewood dealers. Households buy the piece they prefer depending on the amount of money they have and their consumption of firewood per day. The households buy firewood ranging from Ksh. 20 to Ksh. 150 in a single bundle purchased. The firewood dealers informed the author that they obtain the firewood for sale from different sources, which includes; own farm, buying trees from farmers, collecting from the fallow land and forest. Trees bought from the farmers depend on the thickness of the tree and its location.

Table 4: Cost of fuel per month

Fuel type	Mean cost	Std. dev	Min	max	Average Quantity
Kerosene	330.07	164.15	0	680	2 litres
Firewood	249.17	391.62	0	3150	50 pieces
Charcoal	345.08	324.58	0	2000	1 bag

Source: Field survey data 2007

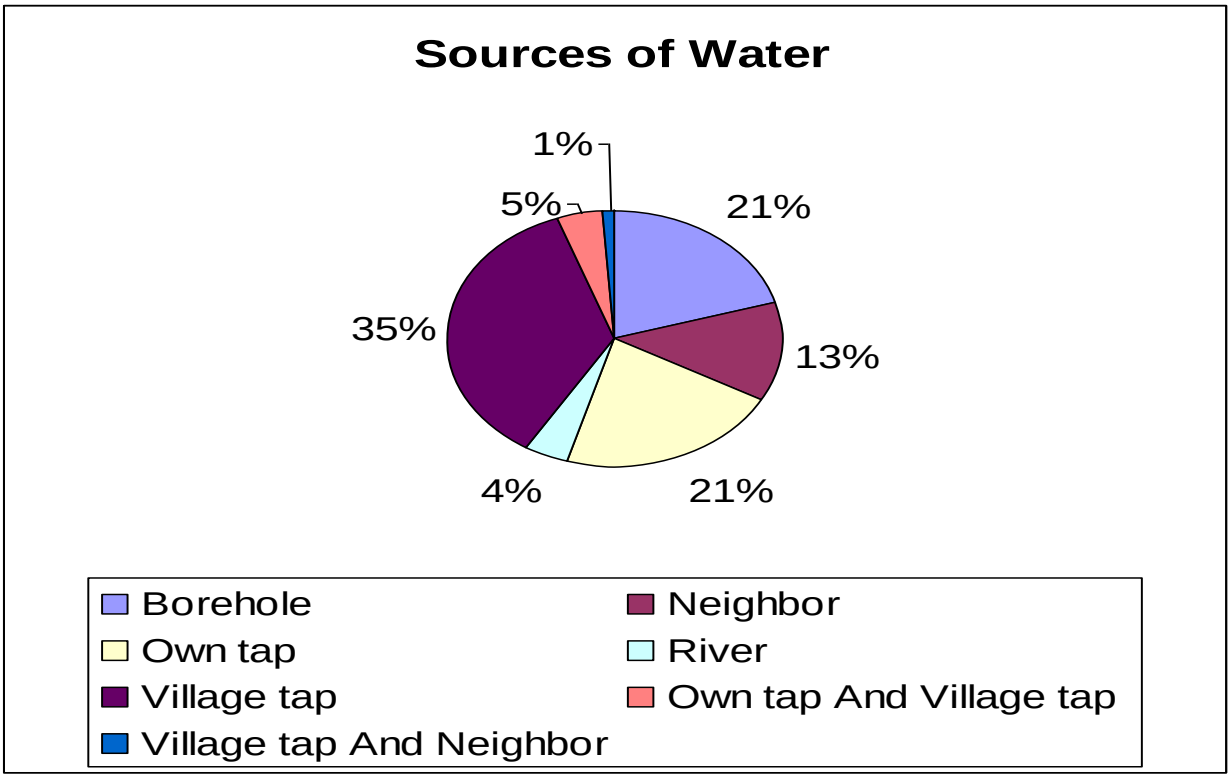
Households indicated that they substitute three main fuel sources namely, firewood charcoal and kerosene. Firewood and charcoal are mainly used for cooking and heating while kerosene is used for lighting with a few using it for cooking. Table 4 shows the sampled households' expenditure on three main fuel type used. Firewood recorded the lowest mean of Ksh 249 and also the maximum cost of Ksh 3150. This indicates that there is evidence of households which combine firewood collection and purchase while others obtain their entire firewood from the market. The study also revealed that charcoal is a close substitute of firewood.

Household water collection statistics

Households sampled reported that they collect water from different sources depending on the water table in the area. In Karai Location of Kikuyu Division and Ndeiya Division household obtain their water mainly from village tap which accounts for approximately 35 per cent of water source in the sampled areas and some from own tap which accounts for 21 per cent where water is supplied three times a week and during the dry seasons tap water is scarcely supplied and all households are forced to collect water in the village tap.

Whereas in Lari Division, households dig manual boreholes to get water, a few obtain water from the rivers.

Figure 2; Households' sources of water



Source: Field survey data 2007

Table 5 reports the collection and queuing time plus the two way travel time mean time spent in collecting water in respect to the different sources in the sampled areas.

Table 5: Mean time taken to source of water in minutes

Source	Karai	Lari	Ndeiya
Borehole	-	26.42	-
Neighbour	30	31.11	25
Own tap	12.56	9.5	10.5
River	-	70	-
Village tap	128.52	102.35	107.95

Source: Field survey data 2007

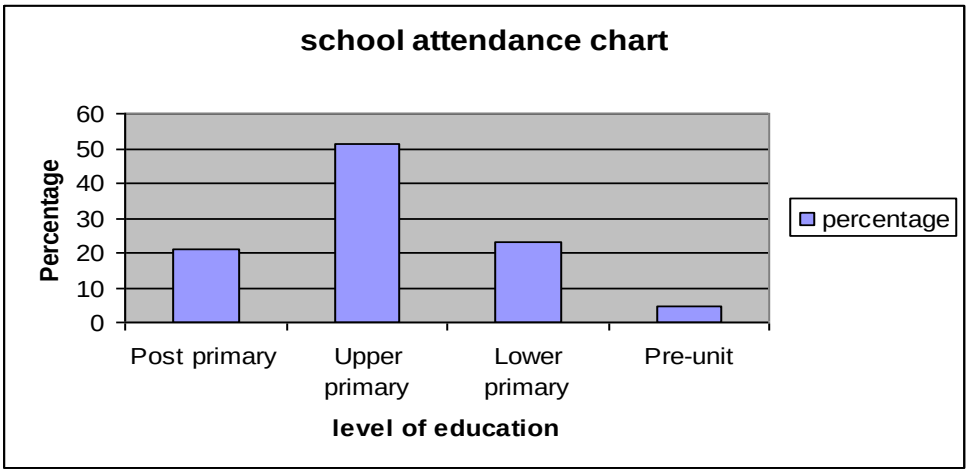
From Table 5 it appears that there is no household which collects water from boreholes or rivers in both Ndeiya and Karai location. However in Lari division majority obtains their water from boreholes and few from rivers. Village taps are key points for water collection

in these three areas while Karai location recorded the highest mean time of 129 minutes which is largely spent on queuing due to scarcity especially during the dry season.

Children schooling and resource collection work

From the sample, the total number of children aged between 5 to 18 years is 609 who are the main focus for schooling children in pre-unit, primary, and post primary level of education in Kenya. Children on average were reported that they start nursery school at an average age of 5 years and join standard one at the age of 6 or 7 years depending on the number of years they spend in pre-unit. Out of the 609 children with education information who are aged between 5 to 18 years sampled, 51 per cent have attained a level of upper primary education. 23 per cent and 4 per cent are in lower primary school and pre unit level respectively. The post secondary level has 21 per cent children who are either in secondary school, polytechnic, universities or have just completed Form Four studies. The school attendance data is summarized using four major categories as shown in figure 3 below

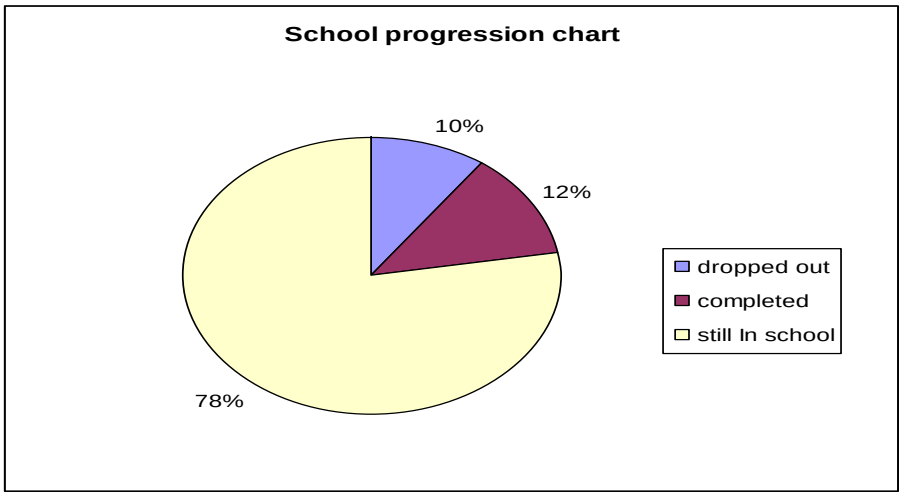
Figure 3; school attendances in primary and post primary school 2007



Source: Field survey data 2007

Out of the 609 children 19 per cent are out of school while 81 per cent are still in school. 10 per cent of the sampled children are out of school due to lack of school fee. The pie chart below shows the percentage of school progress in the sampled children.

Figure 4; grade progressions in primary and post primary school



Source: Field survey data 2007

Those who have ever attended school in the sample were also asked question about repetition and tabulating this shows that 24 per cent of children sampled have ever repeated and 76 per cent have not repeated any class. The drop out rate is about half the number of children who should join secondary school in the sample**.** Table 6 bears the descriptive statistics for children schooling variables

Table 6: Descriptive statistics for children schooling variables

Variable	Mean	Std. Dev.	Min	Max
Age child began school (std 1)	6.25	0.65	4	8
Resource work hours children spend on weekdays	0.58	0.53	0	4
Hours children work weekends	2.07	1.76	0	7
Evening study hours	1.77	0.84	0	5
Average number of children in a household	4.10	1.59	0	9
School type dummy=1 if public school	0.83	0.37	0	1
School type dummy=1 if private school	0.17	0.37	0	1
School attendance dummy(1=attending)	0.88	0.32	0	1
Dummy for lower primary(1=lower primary)	0.24	0.42	0	1
Dummy for pre unit(1=pre-unit)	0.02	0.21	0	1
Dummy for upper primary(1=upper primary)	0.55	0.50	0	1
Dummy for post primary(1=post primary)	0.19	0.40	0	1

Source: Field survey data 2007

The schooling variables reveal that 83 per cent of children in the sample were from public school and 17 per cent from private school. This indicates that majority of rural population are benefiting from the free primary education. On average, children spend 8 hours in school and an hour to collect resources mainly water after school. Children also spend on average one hour forty five minutes for private studies. 9 per cent of children who are involved in resource collection activities reported to be affected by the resource collection work and this are reflected by their inability to complete homework. This is also confirmed by the 9 per cent of children whose teachers' comments in their progress report indicate that the resource collection work was affecting their performance.

From Table 7 below 63 per cent of the school going children collect water while 41 per cent collect firewood. On average 59 per cent of the sampled school going children participate in either collection of water or firewood or both.

Table 7: Summary statistics for children collection activities

Variables	Mean	Std. Dev.	Min	Max
Water collection participation	0.63	0.48	0	1
Firewood collection participation	0.41	0.49	0	1
Resource work participation	0.59	0.49	0	1
Travel time firewood	98.61	91.20	0	360
Collection time firewood	66.37	51.44	0	300
Travel time water	22.68	22.37	2	150
Collection and queuing water time	38.71	42.18	3	240
Firewood total time	168.23	116.82	10	480
Water total time	61.48	60.62	5	390

Source: Field survey data 2007

Children spend 4 hours on average to collect resources where the highest share is for firewood with around 3 hours and water collection takes one hour. For water collection time queuing in the water sources takes around 40 minutes while the travel time takes around 20 min. this indicates that there is many people who collect water from the village tap which contributes the highest proportion of water time.

4.2 Econometrics results

The first outcome of interest that we study is whether children are currently attending school and collecting resources. As these are binary joint outcomes, we estimate a bivariate probit model followed by computation of the marginal effects. The bivariate

probit results of resource collection work and school attendance for 609 children are provided in Table 8.

The marginal effects presented in table 8 are for the conditional probability that the two events occurred. We also carried out a likelihood ratio test of the null hypothesis that the correlation coefficient (ρ) equals zero against the alternative that ρ does not equal zero. The test statistic, 4.79 is chi-squared distributed with one degree of freedom and with a p-value of 0.03 which is less than 0.05. Thus, we rejected the null hypothesis at 5 per cent significance level. Hence, the correlation coefficient (0.27), between the error terms in the two equations of resource work participation and school attendance, is positive and statistically significant. This suggests that the two choices are jointly determined.

Table 8: Estimated Bivariate Probit Model

	School attendance		**resource collection**		**Marginal effects**	
Variables	Coefficient	Robust Std. Errors	Coefficient	Robust Std. Error	Marginal effects	Robust Std. Error
Water minutes	-0.003***	0.001	0.017***	0.004	0.005***	0.001
Girl child	0.135	0.167	0.369***	0.137	0.131***	0.046
age15to18	1.249***	0.198	2.445***	0.355	0.571***	0.050
Mother resource work minutes	0.117**	0.057	-0.080**	0.050	-0.015**	0.017
age6to14	2.948***	0.250	2.582***	0.390	0.858***	0.046
Household size	-0.003	0.044	-0.016	0.040	-0.005	0.014
Post primary	0.310	0.291	1.208***	0.294	0.341***	0.071
Upper primary	-0.651**	0.287	0.925***	0.159	0.229***	0.059
Head years of schooling	0.026	0.027	-0.035	0.026	-0.009	0.009
constant	-1.193***	0.495	-2.396***	0.527		
athrho	0 .279	0.126				
rho	0.272	0.118				

Number of observations =609 Iterations completed = 3 Log likelihood function =-402.70721
Wald test of rho=0: chi2 (1) = 4.79451 Prob > chi2 = 0.0286
Marginal effects after biprobit y = Pr (School attendance=1, child resource work=1) (predict) = 0.61169809

Note: *Significance at 10% ** significance at 5% *** significance at 1%;

The above results provide indications of those factors that influence the sampled children's likelihood of engaging in resource collection work as well as the determinants of school attendance. These results imply that age groups 6 to 14 years and 15 to 18 years significantly determine resource work participation and school attendance, based on their positive signs. Additionally, being in the age group 6 to 14 years increases the child's total marginal effect of combining participating in natural resource collection work and

school attendance by about 86 per cent relative to those in age group 19 to 24 years. Those in age group 15 to 18 years increases the total effect of participating in resource collection and school attendance by 57 per cent relative to age group 19 to 24 years. In both age categories the total marginal effect is positive.

The level of children education was categorized into lower primary (standard 1 to 3), upper primary (Standard 4 to 8) and post primary school (Form 1 and above). Those in post primary variables have the expected positive sign of both participation in resource collection and schooling. Those children in upper primary are less likely to be attending school as the school attendance coefficient is negative, this may be due to high drop out rate. Being in upper primary level will increase the positive total marginal effects of combining the two decisions by 23 per cent while post primary is by 34 per cent relative to those in lower primary. One of the reasons why the upper primary has a lower percentage than post secondary is due to the high drop out rate in the sampled region.

With the presence of a girl child in a household, signs for resource collection are positive and statistically significant, and being a girl increases the likelihood of combining resource collection and school attendance by 13 per cent relative to boys. The involvement of women in resource collection positively affects the likelihood of a child involvement in resource collection and negatively affects child involvements in resource collection. This indicates that adult involvement in resource collection will reduce the burden of children in resource collection. The household size negatively affects both resource collection and school attendance. Although household size is not significant the negative signs of household size affecting school attendance suggest that as households members increases the household asset base is constrained and this may lead to children not attending school due to poverty. Those who don't participate in school reduce the burden of those in school in a large households and thus negatively affecting child resource collection.

Collection time measured in minutes for water was estimated as the environmental variables. The water minutes negatively affect school attendance and they are statistically significant in determining the total marginal effect of school attendance and resource collection work. The marginal effects of the environmental variable is very low, for

instance, a one minute increase in water minutes increases the total marginal effect of combining resource collection and school attendance by 1 per cent.

We also estimated the Instrumental variable probit model. The time children spend collecting water is used as instrument for resource collection which is used to correct for endogeneity.

Table 9: IV Probit results

Variables	Coefficients	Robust std. Err.	z	P values
School attendance				
Child resource work	-0.942	0.320	-2.950	0.003
Girl child	0.213	0.151	1.410	0.160
Age15to18	1.612	0.240	6.720	0.000
Mother resource work minutes	0.080	0.049	1.650	0.100
Age6to14	3.098	0.235	13.180	0.000
Household size	-0.013	0.041	-0.330	0.744
Post primary	0.601	0.267	2.250	0.025
Upper primary	-0.259	0.269	-0.960	0.335
Head years of schooling	0.013	0.024	0.560	0.573
constant	-1.050	0.451	-2.330	0.020
Child resource work				
Girl child	0.098	0.035	2.850	0.004
Age 15 to 18	0.582	0.051	11.350	0.000
Mother resource work minutes	-0.022	0.010	-2.190	0.028
Age 6 to 14	0.606	0.045	13.550	0.000
Household size	-0.007	0.010	-0.710	0.479
Post primary	0.315	0.049	6.440	0.000
Upper primary	0.281	0.040	7.100	0.000
Head years of schooling	-0.008	0.006	-1.340	0.181
Water minutes	0.003	0.000	9.530	0.000
constant	-0.032	0.098	-0.320	0.747
/lnsigma	-1.002	0.025	-39.730	0.000
/athrho	0.608	0.156	3.890	0.000
sigma	0.367	0.009		
rho	0.543	0.110		
Wald test of exogeneity (/athrho = 0):	chi2(1) = 15.17	Prob > chi2 = 0.0001		
Number of observation=609				

The significant Wald test for exogeneity indicates that we reject the null hypothesis, that there is no correlation between the errors in the schooling equation and the resource collection equation. The positive rho of 54 per cent indicates that the two decisions are correlated. The school attendance is negatively affected by resource collection work as indicated by the negative significant resource collection coefficient. Although the household head years of schooling is not significant, it has the expected signs that is, the

head education positively affect child school attendance and negatively on their resource collection work.

Household characteristics and household composition variables also affect the likelihood of a child attending school or doing resource collection work. The household size is insignificant but has a negative effect on both schooling and resource collection implying that children from large household are not likely to collect resources but can also negatively affect schooling due to factors such as poverty.

The high positive probit index of the age category of 6 to 14 years suggest that this is the age most likely to be attending school as compared to the age 15 to 18 years which has a lower probit index relative to those over 18 years of age. Due to the high drop out rate the probit index for a child being in upper primary is negative and insignificant while that in post secondary category probit index is positive and significant relative to those in lower primary category. The presence of women being involved in resource collection work positively increased school attendance and negatively determine the child involvement in resource collection especially in firewood collection work which takes more time compared to water collection.

Determinants of Children's School Performance

One variable is used to estimate school performance which is constructed from the collected information about last exam sat results which are averaged and any mark below the average of 306 marks out of 500 marks is labelled below average and is the dependent variable of the performance model. The results from the bivariate model are presented in appendix 1 (Table A1). The insignificant negative rho coefficient (-0.17) from the Bivariate probit suggests that participating natural resource collection work and school performances are not jointly decided. Therefore we estimated the univariate probit of school performance and resource collection as one of the explanatory variable for 486 children who had performance and collection activities information.

The results in table 10 shows that, as children progress to post secondary school they are likely to perform below the average mark as is expected since the curriculum content becomes complex. The results indicates that the type of school children attend is a major determinant of performance, the results shows that children in public schools are likely to

perform below the average mark relative to those in private schools. The likelihood of a child being in post primary and performing poorly in school increases by 37 per cent relative to those in lower primary school.

Table 10: Probit model of school performance results

variables	coefficients	Robust std error	Marginal effects	Robust std Error
Child resource work	-0.213	0.178	-0.081	0.067
Water minutes	0.001	0.001	0.000	0.001
Age	-0.116	0.115	-0.044	0.044
Age squared	0.005	0.005	0.002	0.002
Girl child	-0.145	0.123	-0.056	0.047
Mother resource work minutes	-0.071	0.044	-0.027	0.017
Household size	0.069*	0.039	0.026*	0.015
Post primary	1.284***	0.345	0.388***	0.070
Upper primary	0.196	0.204	0.075	0.078
Head years of schooling	-0.003	0.024	-0.001	0.009
Firewood minutes	0.001	0.001	0.000	0.000
Public school	0.727***	0.175	0.283***	0.066
constant	0.032	0.713		
Number of observation=486 Iterations completed =4 log pseudolikelihood = -294.43067				

Note: *Significance at 10% ** significance at 5% *** significance at 1%;

Although the effect of participation in resources collection work is negative, it is not significant; the result may suggest that school performance is more related to the child's ability than to external pressure of resource participation work. This finding is also confirmed by Nankhuni and Findeis (2003) when they estimated determinants of school progress using variables such as progress at the right class at the right age and progress in the senior primary school.

5.0 Conclusion

This paper provides new insights into the current debate on the inter-links of resource scarcity and human capital development. In particular, the study examines the links between natural resource collection work and children schooling in Kiambu District. The study was motivated by the growing concern about the anticipated negative effect of environmental degradation on human capital development. The study uses cross sectional data collected from Kiambu district in Lari, Ndeiya and Kikuyu division in April and May 2007. Descriptive statistics indicates that 88 per cent of the sampled children attend

school with a dropout rate of 10 per cent. It also indicates that 59 per cent of school going children combines schooling and resource collection. The data further shows that 83 per cent of children are in public schools relative to private schools.

The main study hypothesis is that; as resources becomes more scarce households will invest more time in collecting them and this will adversely affect the children's school attendance and performance. Since the decisions to collect resource and school attendance are jointly determined, the bivariate probit model was estimated. The results indicate a positive correlation between resource collection and school attendance. The instrumental variable probit was also estimated to correct for endogeneity of the two equations. The main findings are that children's school attendance and progress is negatively affected by scarcity of natural resources. Children's school attendance is affected through the increased work that results from scarcity of natural resources.

The school performance and resource collection model indicates a negative interlink however, the effects of resource collection works on performance were not significant which suggest that performance mostly depends on child's ability. There is a positive relationship between performance and type of school the child attends which is evident from the public schools dummy relative to private schools. Increased school attendance by children in public schools can be associated with the free primary education although the quality seems to have been compromised as evidence of lower school performance by children in public schools relative to private schools.

From the research findings, there is need to reduce the child involvement in resource collection through several ways. First, increasing water supply in the areas may reduce the time children spend queuing for water at the source of water. The water supply can be enhanced through tap water projects for the rural dwellers which will reduce time for fetching water and the cost of buying the water. Another policy that can be adapted for the areas with access to village tap is increase the number of village taps or community taps in the villages to a short distance from each other which will reduce the time children spend in queuing and travelling. Management of existing water resources can be encouraged through water conservation measures.

To reduce the time children spend to collect firewood especially on weekends, the available alternatives of fuels for cooking should be improved. Access to modern energy such as liquidated petroleum gas and solar energy, improvised '*jikos*' could provide time for children to go to school or to spend time on school work and personal study which was revealed by this study to be on an average of one hour per day. The presence of women being involved in resource collection work positively increased school attendance implies that education of children can be enhanced even through adjustments such as a change in cultural attitudes towards encouraging men's involvement in resource collection activities.

There is need to carry out this kind of studies with more random experiments on the instrumental variables to be used for correcting endogeneity. Information on household assets and income can be collected to estimate firewood and charcoal demand functions. Furthermore, the performance study can be estimated using panel data to control for other factors that affect child's performance and also to have a broader implication of environmental degradation on schooling. In addition, there still exists a need for research in this area of linking environment, schooling and poverty for the whole country, Kenya.

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Appendix 1

Table A1: bivariate model of resource collection work and school performance results

Variables	coefficients	Robust Std. Error	P value
Below average mark			
Water minutes	-0.000	0.001	0.932
age	-0.168	0.114	0.140
Age squared	0.007	0.005	0.117
Girl child	-0.155	0.122	0.206
Mother resource work minutes	-0.061	0.043	0.157
Household size	0.074	0.039	0.055
Post primary	1.218	0.343	0.000
Upper primary	0.179	0.203	0.378
Head years of schooling	-0.001	0.024	0.955
Firewood minutes	0.000	0.001	0.594
Public school	0.712	0.174	0.000
_cons	0.146	0.719	0.839
Child resource work			
Water minutes	0.099	0.025	0.000
age	1.646	0.303	0.000
Age squared	-0.079	0.015	0.000
Girl child	0.351	0.169	0.038
Mother resource work minutes	-0.129	0.058	0.027
Household size	-0.155	0.046	0.001
Post primary	2.435	0.753	0.001
Upper primary	0.205	0.240	0.394
Head years of schooling	-0.026	0.036	0.469
Firewood minutes	0.033	0.009	0.000
Public school	0.371	0.278	0.182
_cons	-7.844	1.628	0.000
/athrho	-0.180	0.156	0.251
rho	-0.178	0.152	
Wald test of rho=0:	chi2 (1) = 1.31792	Prob > chi2 = 0.2510	