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Implications of Environmental Chores for Schooling: Children's Time Fetching Water and Firewood in Tanzania

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Abstract

In many developing countries, children devote substantial time to collecting firewood and fetching water. Is there a connection between such time-consuming work and children's schooling? If so, environmental degradation may have serious detrimental implications for children's education. To explore this question, this case study set in rural Tanzania uses evidence collected from children and their mothers about children's environmental chores. Although the sample is small, we find some descriptive quantitative evidence as well as qualitative evidence from focus groups with children supporting such a link, consistent with results from the few econometric analyses set in Africa. We also document substantial demands by schools for students to fetch water. The proposed conceptual framework takes into account confounding factors including school-related violence, which affected more than one-third of children in this study. We make a case for future research based on larger data collection projects designed to explore these issues more fully.

Keywords

Tanzania; schooling; environmental chores; child labor; natural resource collection; water; fuel wood

Introduction

Cross-sector analysis and collaboration is a goal of governments and major funders of development projects in low-income countries, yet many connections across sectors remain to be made. Here, we consider a potential connection between schooling and the environment. We conducted a case study involving residents of two villages in rural Tanzania to explore (1) whether children's responsibilities for fetching water and firewood

are a link between schooling and environmental conditions and (2) what factors complicate this question. This essay aims to draw attention to the possibility and implications of such a link. If this link exists, then environmental degradation that leaves families further from water and wood sources, even if not reaching a point where it fundamentally alters societal structures, has implications for human capital accumulation (Nankhuni and Findeis, 2004; Nankhuni 2004).

Many children in rural Tanzania spend substantial time fetching water and firewood, in addition to their other chores. While increasing attention is being paid to water scarcity problems and deforestation, the interaction between natural resource scarcity and human capital development has, in large part, been overlooked.¹ Yet, as Frances Vavrus (2003, p. 109) writes:

For people living on or near the margins, anything that makes life more difficult can push schooling further out of reach. In a community largely dependent upon agriculture, scarce or expensive water can do exactly that. Water can have the indirect effects of cutting into enrollment and attendance, of blunting the power of schooling, in other words, before that power has had a chance to work. If we want to more fully understand what schooling can and cannot accomplish in the Third World, then we have to appreciate more fully the relevance of something as unrelated as water.

When children spend substantial amounts of time fetching water and gathering firewood —“environmental chores”—it seems likely that this would have some effect on their school attendance and performance, given the fixed amount of daylight for all of their chores, schooling, studying at home, and play.² However, with exceptions discussed below, the literature has been largely silent on this question, especially given that a sizeable fraction of the world’s young people may be affected. Our analysis provides limited evidence of such a link, one that is not as obvious or straightforward as one might expect, but enough, we argue, to warrant additional research. Our evidence suggests factors often overlooked in this kind of analysis that should be included in future studies. This essay provides a conceptual framework and suggests directions for linking natural resources and children’s schooling.

Tanzanian context

Water is the most basic of all human necessities, and wood for cooking is a close second in many parts of the world, including much of sub-Saharan Africa. As human populations increase and aspire to better lives, demands for firewood and water grow. Tanzania has one of the highest population growth rates in the world, at 2.9 percent in 2012, which is expected to continue for the foreseeable future. Along with a high incidence of poverty despite relatively strong economic growth (GDP growth of 5–7% since 2000), this places pressure on limited water resources, land and forests (Falkenmark and Widstrand, 1992; United Republic of Tanzania (URT), 2009). Forests are rapidly being degraded or destroyed, and, as the ecosystem is affected, nearby water sources dry up for all or part of the year.

¹We summarize below a small number of studies set in Africa with such a focus.

²Much of Tanzania is not electrified. Studying by candle or kerosene lamp is possible, but more difficult and expensive.

Village contexts

Our study villages are in Kondoa District, one of seven districts of the Dodoma region, located in the northeast of the mainland. The selection of these villages is described in the next section. They are located at an altitude of 1200–1500m and experience the semi-arid weather of the region. The 2012 Population and Housing Census indicates that Kondoa District had a total population of 269,704 with an average household size of 4.7, consistent with the national average (4.8). The majority of villagers belong to the Rangi tribe and are Muslim. Agriculture and pastoralism, largely for own consumption, are the main economic activities in the area. Crops cultivated include millet, sorghum, groundnuts, maize, rice, cassava and sunflower, with cattle, goats and chickens the primary livestock. Households supplement their incomes with charcoal production and brick firing. Both of these activities are detrimental to the environment as they require a lot of fuel-wood. The region's weather conditions and economic activities place considerable pressure on water supplies.

Cooking fuel

Firewood is widely used for cooking in all regions except in highly urbanized Dar-es-Salaam. Charcoal (made using wood) is the second most common energy source for cooking, used by about half of urban households. It is almost exclusively men who produce and sell charcoal, while women and children are mainly responsible for gathering firewood (e.g., Biran *et al.*, 2004). In the study villages, gathering firewood typically takes place once or twice each week.

Water

Access to water varies substantially in Tanzania, not only between urban and rural areas—and within them by socio-economic status—but also by season. In rural areas, only some villages have been provided with drilled wells and pumps. In one of our study sites, water was obtained in the dry season by digging in the sandy bed of a dry river and waiting for water to seep in. Women and children have primary responsibility for fetching water and typically do this nearly every day.

Education

The importance of schooling to economic development and improved quality of life in Africa and elsewhere is widely acknowledged. In the early post-colonial period, the Tanzanian government emphasized school education, and enrollment rates increased substantially, especially for primary school. The 1980s and 1990s witnessed a decline, with the gross primary school enrollment rate falling to about 63 percent by 2000 from nearly universal at its peak. Provision of quality schooling is still recognized in Tanzania as central to socioeconomic development, and progress has been made in increasing enrollment rates in recent years, but concern remains about late age of entry, dropout, and the quality of education (e.g., Burke and Beegle, 2004; Kondylis and Manacorda, 2012; Vavrus, 2003).

Literature and conceptual framework

Numerous factors contribute to these concerns about impediments to children's educational success, many of which have been studied, but little attention has been given to children as

fetchers of water and wood, especially in rural areas where infrastructure is less well developed and natural resources thinly spread. Anthropological evidence shows that “village parents don’t feel much need to make adjustments in domestic arrangements on behalf of their schoolchildren” (Lancy, 2015, p. 354); e.g., water-carrying might be expected first thing in the morning, even if that makes children late for school. There is a large literature on child labor, but as Edmonds (2007, p. 3698) describes, domestic work is “too often ignored in child time allocation studies”. Similarly, Webbink *et al.* (2012) emphasize the lack of attention in the child labor literature to ‘hidden child labor’—i.e., unpaid work in family enterprise or in domestic tasks, the latter including environmental chores. Still, some studies consider relationships between children’s chores and school enrollment (e.g., Assaad and Levison, 2010; DeGraff and Bilsborrow, 2003; Koissy-Kpein, 2012; Lyon *et al.*, 2013) with mixed results. Such studies typically group environmental chores with all other domestic work, as do their data sources, so cannot address our questions. In addition, a few studies consider the effects of the environment on time allocated to environmental chores and time use more generally, but only for adults or, when children are examined, not including a focus on schooling (e.g., Biran *et al.*, 2004; Boone *et al.*, 2011; Cooke, 1998). Biran *et al.* (2004) find that when Maasai women in Simanjoro, Tanzania, have the help of a daughter in collecting firewood, the women spend substantially less time on that task.

Household demand for child labor related to water and fuel needs may interfere with school attendance, study time and, ultimately, the ability to learn and progress through school. Rogers (2014) uses panel data for Tanzania from 1994 to 2004 to analyze the effect of forest access on schooling; she estimates that adding an hour to regular firewood collection trips reduces completed education by 1/5 of a year. Rogers’ model is intended to produce a dollar-value estimate for this effect, and it does not take into account who does the chore, nor does it capture water-fetching; we do both. Similarly, Koolwal and van de Walle (2013) estimate associations between distance to water source and school enrollment in rural areas of several countries but do not examine who does the chore. Lihwa *et al.* (2015) find negative associations between schooling measures (attendance and exam performance) in Tanzania and a multi-dimensional remoteness indicator which includes children’s perceptions of distance to the closest water source, but do not examine this component separately.

Three economic studies, set in Ethiopia (Gebru and Bezu, 2014), Kenya (Ndiritu and Nyangena, 2011), and Malawi (Nankhuni and Findeis, 2004; Nankhuni, 2004), directly address children’s work in “environmental resource collection” (i.e., fuel, fodder, and water) and its implications for schooling. All three studies use survey data, supplemented with focus groups in Ethiopia; all endeavor to address the potential endogeneity of environmental chores as a determinant of children’s schooling using instrumental variables approaches. The econometric framework for all three studies is established in the Malawi analysis. First, a bivariate probit model of participation in environmental chores (for *any* amount of time) and being in school is estimated; based on these results, the authors in each study conclude that these activities are not significantly related when a simple yes/no measure of environmental chores is used. Second, the effect of time devoted to environmental chores on attending school is estimated using a two-stage instrumental variables approach. In the Malawi study, which uses several measures of local natural resource scarcity as instruments, the authors conclude that greater resource collection time among children ages 6 to 14 significantly

reduces the probability of being in school for the total sample, and for girls but not for boys when estimated by sub-sample. The Ethiopia and Kenya studies, while characterized by arguably less convincing identification strategies due to data limitations, reach similar conclusions (for children 7 to 18, and 5 to 18, respectively, for samples of rural households). The one notable exception for our purposes is that, for Ethiopia, the effect of time in environmental chores on school participation does not differ significantly by gender (based on a gender interaction term), and the Kenya study does not test for such gender differences. Nankhuni (2004) also finds evidence of negative effects of children's time devoted to natural resource collection on progress through school (measured by whether children 10 to 18 have reached the upper level of primary school) for the total sample and for girls, but not for boys.

These three studies, conducted in regions of Africa that in many ways are similar to our study sites, provide empirical evidence supporting the exploration of these questions in rural Tanzania (albeit using only descriptive analysis here due to limited sample size). In addition, none of these studies examines the fact that children also sometimes fetch water and firewood for their schools. As we have observed, even urban children in Tanzania may go to school with a bucket or jug, filled with water or to use later in the school day to fetch water. This is one more way that water scarcity may decrease learning. These dynamics could become important contributing factors to poor educational outcomes in Tanzania, as rapid population growth places increasing pressure on the natural environment. While human capital development is critical to addressing threats to the natural environment, at the same time it may be compromised because of children's engagement in environmental chores.

In spite of the apparently straightforward relationships mentioned above, the study of possible links between children's education and environmental conditions is complex and includes many situations where potential simultaneous decision-making and reverse causality suggest that endogeneity exists, and where unmeasured factors imply the likelihood of confounding. Figure 1 aims to describe some of these relationships, although undoubtedly more exist.

In the center of Figure 1, we use circles to represent a young person's environmental chores (time spent fetching water and firewood) and schooling success, which ideally should not only capture attendance and tardiness but also grade progression and true learning (e.g., literacy and numeracy). While chores may have negative effects on educational outcomes via time out of school, it is also possible that children who have not performed well in school will be asked to spend more time on such chores (reverse causality). Alternatively, there may be a kind of social contract such that children who want to stay in school understand they must be diligent in their chores.

School-related violence, if left unmeasured (as in most previous studies on the environment-education link) could be an important confounding factor. Harber (2004) has documented high levels of physical and verbal abuse of students both in school and en route to school. If children prefer to miss school for these reasons, environmental chores might be a convenient excuse. Much of the rest of Figure 1 is self-evident. Due to funding limitations, we were less successful in capturing some dimensions of Figure 1 than others when collecting data, and some were completely beyond the scope of our exploratory project. For example, we have

reasonable information on school-related violence, but none on school proximity or alternative activities of young people, such as other chores (cooking, cleaning, child care), labor force work (farming, herding), or play. We discuss other components of Figure 1 as we present our evidence.

Data and methodology

Survey of children 10–17 and their mothers/guardians

We rely on survey and focus group data from Kondoa District, Tanzania, from 2011.³ Our starting point was data collected in a number of villages in northern Tanzania in 2010 by the Whole Village Project (WVP).⁴ The WVP surveyed a random sample of households in each village but did not include detailed questions about children's schooling or how the household's water and fuel needs are met. We re-visited all WVP sample households with school-age youth in two villages that were chosen purposively to generate variation in access to water and firewood. Although children under age 10 may do a lot of chores, we did not include them due to IRB concerns about vulnerable populations. Instead, we focused on 10–17 year-olds. We worked with the WVP field team to identify the previously-interviewed households in Village-K and -M (anonymized) and to re-interview youth ages 10 to 17 and their mothers or female guardians. We used parallel modules on key topics that asked comparable questions of the mothers about the children and of the children themselves. In addition, mothers were asked summary questions regarding the household's collection of water and firewood. The sample size for the more detailed 2011 survey is 57 households and 114 children.⁵

The survey data were collected using hand-held computers (PDAs), and answers to open-ended questions were translated simultaneously into English for the American investigators. Quotes from responses to open-ended questions should be understood to capture the sense but not the exact words of the interviewee. The field research was timed to coincide with the second month of the school year, August, and well into dry season, which generally stretches from June through October.⁶ Because of seasonality in water availability, our analysis is not representative of children's experience over the entire school year.

Focus groups with children

We conducted ten focus groups using guided but open-ended questions about children's experiences related to schooling, why children leave school, and their roles as fetchers of water and firewood. Because we expected substantial gender- and age-related differences in responses, and because girls often will not talk with boys present, focus groups were divided into groups for younger (10–12) and older (13–17) girls and boys. A caveat is that school children are over-represented, and out-of-school children under-represented, as they were harder to locate. Each group included a facilitator and a note-taker, both Tanzanian; focus

³The study was approved by [university name withheld for anonymous review] IRB and the Tanzania Commission for Science and Technology (COSTECH), the organization responsible for issuing research permits in the country.

⁴The WVP data are available via the Minnesota Population Center.

⁵We also endeavored to collect from village schools information about attendance and class rank for enrolled sample children. Due to missing/incomplete school records, this information unfortunately cannot be used.

⁶The end of dry season, just before the rains, is the driest time of year.

groups were also audio-recorded. Shortly after the focus group, the note-taker made an English-language transcript, which the facilitator checked and edited. Not only the words but also information about the expression or emotion of the speaker were recorded. Again, quotes capture the sense but not the exact words of the participants.⁷

Methodology

We are particularly interested in identifying the challenges facing rural Tanzanian children to being successful in school, and whether the demands to provide water and wood for their households (or schools) are an impediment. We present descriptive statistics on these topics, and use NVIVO software to isolate themes from the focus groups. Given our very small sample size and the complexity of relationships outlined in Figure 1, we do not utilize multivariate statistical modeling techniques as in some of the literature cited above.

We use two measures of children's time in environmental chores: (1) a yes/no indicator of whether the child engaged in each chore (fetching water or gathering firewood) during the seven days prior to the interview; and (2) an estimate of the amount of time devoted to the chore in the reference period among those who participated. The latter is derived from a series of questions about number of chore trips taken, and usual amount of time, recorded in minutes, for a round trip for each chore during this time of year. We multiply these variables to derive an estimate of the minutes devoted to each chore during the past week. The resulting distributions displayed a small number of extremely high outliers. Accordingly, guided by the distributions and our general knowledge of these activities, we top-coded water fetching minutes to a maximum of 1000, and wood gathering minutes to a maximum of 600.⁸

Female adult vs. youth respondents

We strategically asked identical or very similar questions about children's participation in environmental chores to the children themselves and to their mothers/female guardians (hereafter called "women"). There is a small literature that speaks to the use of proxy respondents in the measurement of child labor, suggesting differential patterns of responses with respect to labor force work (e.g., Dammert and Galdo, 2013; Dillon *et al.*, 2012). Similarly, there are reasons to expect children to give different answers than adults to time-use questions. Children's and adults' sense of time may differ, especially in the absence of timepieces. Also, a woman may send a child to collect firewood, but not know what he is doing the entire time he is away. As in Reynolds' (1991) seminal work from Zimbabwe, our focus group boys reported mixing play and chores, e.g.: "*When I go with my friends to collect firewood, we knock down baobab nuts and eat them*" (boy 13–17, Village-K). Then, when asked how long it takes to fetch firewood, such boys have a more complex estimation

⁷We have, in some cases, minimally corrected the spelling or grammar of the field team translators to make a quote more understandable, but without changing its meaning.

⁸The numbers of top-coded responses are 8 and 11 (out of 114) using children's responses for wood and water, respectively (or 8 and 13 using mothers' responses); the ranges of the corresponding recorded values are 720–1800 minutes (or 720–1440) for wood, and 1080–1800 (or 1080–3360) for water. The minimum and median values for participants are 60 and 360 minutes (or 60 and 240) for wood, and 10 and 180 minutes (or 5 and 240) for water. We set the top-coding thresholds well above the medians, and with a sizable gap between thresholds and the next largest recorded values. The patterns we report are not sensitive to the top-coding, but the average levels are somewhat larger without top-coding.

task that is more prone to error if they subtract out the play time. If, instead, they include play time in their reported numbers, that again causes their estimates to differ from women's.

We see such differences in our data, particularly for responses regarding minutes per round-trip for each environmental chore. For example, of the 79 pairs of observations with data on water fetching time from both respondents, only 17 gave the same response. For another 27 pairs the values are close (within 30 minutes), however, for the remaining 35 the responses differ by at least an hour, and sometimes much more. Most often, though not universally, the child's time response is greater than the woman's. We observe similar differences for the data on firewood gathering time. Accordingly, we conduct parallel analyses using children's responses and women's responses (about the children) for the environmental chore measures and discuss whether the results are sensitive to these different measures. We often report statistics for both measures, in the form of a range.

Focus group recordings were translated into English and read first without coding to identify common themes addressed by focus group participants (Gibson and Brown, 2009). We then used Nvivo, a software program widely used in qualitative research, to code major themes (notes) from the comments, using bottom-up theory and thematic analysis approaches.

Findings

Who does environmental chores?

When considered at the individual level, there are substantial differences between the responses of children and women regarding children's engagement in environmental chores. When averaged and top-coded as in Table 1, such differences are less pronounced, but the general pattern of children reporting a greater degree of participation than reported by women holds for both chores, as well as a higher level of engagement in wood gathering and in total chore time than women report. The overall picture that emerges about who does environmental chores is consistent across children's and women's responses.

More than 75 percent of 10–17 year-olds fetched water in the seven days prior to the interview, as shown in brackets in Table 1. Fewer children participated in gathering wood during the reference period, consistent with our understanding that, in this region of Tanzania, fetching water is a nearly daily necessity for most households whereas firewood tends to be collected in large amounts, less frequently. Still, about 37–40 percent of the sample children participated in gathering wood in the week prior to the survey. Roughly one-third performed both chores. Almost all children who gather wood also fetch water, while some only fetch water, and some do neither. Table 1 also presents estimates of the average time devoted to environmental chores during the reference week for children who participated; overall this averages over eight hours per week ($SD=7.8$ – 8.2 hours) for both chores combined.

As anticipated, girls are substantially more likely than boys to participate in each of these chores. Overall, among children ages 10–17 who participated in environmental chores, girls spent more time per week (8.9 hours) than boys (6.9–8.1 hours). Younger children (ages 10–

14) are more likely to have engaged in each of these chores than are older children (ages 15–17), and are substantially more likely to have done both chores during the week. Children ages 10–14 spent several hours more per week (8.9–9.8 hours) than did 15–17 year-olds (5.3–6.2 hours). Most of these observed differences are statistically significant at conventional levels, despite the small sample size. These patterns suggest that responsibilities are gendered and change with age.

For the full sample, more time is spent collecting firewood (5.7–6.2 hours) than fetching water (4.7–6.0 hours), consistent with a general pattern of fewer but more time-consuming trips for firewood. In focus groups, children of all ages report spending two to six hours on weekends going to “the bush” to cut wood. They go with friends, neighbors, siblings, mothers, other relatives, or in larger family groups, but no child reported going alone to fetch wood. Among those who collected wood, boys (and older children) spent more time on this chore than girls (and younger children), though these observed differences are not statistically significant. Perhaps older boys are considered more capable of cutting branches, or less vulnerable to wild animals or sexual predation. Focus group respondents told us they worry about such things. “*We go [to get firewood] with another person because there are people who rape and chop off parts of people’s bodies.*” (girl 13–17). Girls worried about being raped, and both girls and boys mentioned fears of snakes, hyenas, lions, wild pigs, and murderers. On the other hand, boys (but not girls) reported having fun together as they get firewood, telling stories and riddles: “*We feel so happy as we tell stories and have some adventures.*” (boy 10–12). This may also increase the time boys report for this task.

In contrast, fetching water is a daily chore sometimes done alone, in spite of children’s fears, e.g., “*If water is too far away, one can meet dangerous wildlife that come to drink water.*” (boy 13–17). In Village-K, older girls reported going to the river after school, to get water: “*...it takes much time because it is far*” (girl 13–17). Time spent on chores is affected by whether going on foot is one’s only option. It was for most focus group respondents, but some families have bicycles used for environmental chores, while a few children mentioned having donkeys or having/renting carts (usually pulled by boys or men).

The variation between the two sample villages suggests a large role for structural factors in children’s time doing environmental chores. Table 1 shows higher percentages of children engaged in these chores in Village-K, especially for gathering wood (about 52–53% vs. about 20–24% for Village-M). In Village-K, children also spend about 6–8 hours/week fetching water, compared to almost 3 hours for Village-M. These results reflect the greater environmental stress in general in Village-K, along with the availability of several public water taps in Village-M. The majority of households in Village-K rely on surface water (e.g., from ponds, streams, holes dug in dry riverbeds) as their primary water source. The data indicate that average time fetching water is much smaller for children whose households rely on water taps versus other sources. Taken together, these differences result in much more of children’s time devoted to environmental chores in Village-K (11–12 hours) than in Village-M (under 5 hours) each week. These differences between villages are statistically significant at conventional levels.

While we explored other factors that might systematically affect whether children fetched water/wood, e.g., size and demographic composition of household, female-headship, education of the female respondent, no clear patterns emerge. However, a few additional relationships vis-a-vis *time* in environmental chores are of interest. Using either children's or women's responses, girls and boys in households with a more highly educated female respondent (i.e., four or more years of school) devote less time to fetching water and gathering wood, while those from larger households devote more time to fetching water based on children's responses. We speculate that female respondents who have attained basic levels of literacy and numeracy may place more value on children's time spent in school and in after-school studying. In any case, this finding suggests a greater burden of environmental chores for children with less-educated mothers/guardians.

Environmental chores and children's schooling

Is there evidence of conflict or tension between fetching water or firewood and participation or success in school? Possibly children are able to accommodate these chores with their schooling schedule, given relatively short school days. Because we did not succeed in collecting rank-in-class or attendance records from schools, we rely on survey data on school enrollment. For those in school, we examine measures related to success in school: days absent from school and amount of time devoted to homework. Finally, we consider the demands that schools place on children to supply water to their schools.

School enrollment in this region of Tanzania is relatively high, with 78 percent of our sample reported as in-school at the time of the survey.⁹ In-school rates, as expected, are higher for younger children than older children (approximately 90% for ages 10–14 and 50% for ages 15–17), and are also higher for girls than for boys (approximately 86% for girls and 69% for boys). Any differences in chore participation rates by school status that are of meaningful magnitude suggest, contrary to our hypothesis, that in-school children are *more* likely to perform these chores (see Table 2). In contrast, we do see some evidence for girls of conflict with schooling in the average time devoted to chores, conditional on chore participation. Average hours fetching water are greater for those *not* in school for girls (6.6–10.4 hours, vs. 5.4–6.1 for those in school) and also for children in Village-M, though the opposite holds for boys (3.1–3.9 hours if not in school vs. 5.6–6.0 in school) and Village-K. Regarding time gathering firewood, we see similar evidence of conflict with schooling for the full sample, both villages and for girls, but not for boys. While the numerical values differ, the patterns again are nearly identical for children's and women's responses.¹⁰

We next consider whether in-school rates were lower among children who fetched water or firewood, as this could indicate conflict between school and environmental chores. There is no such pattern in the data (see Table 3), consistent with the findings of the studies set in Ethiopia, Kenya and Malawi reviewed above.¹¹ We further explore this question using

⁹Information on school enrollment was collected from both the children and the adult female respondent. For this variable, there is almost no difference between children's and women's responses, with just a few missing values for the former. We use the more complete responses of the women.

¹⁰Most of the observed differences reported here for Table 2 are not statistically significant at conventional levels, as the even smaller size of the conditional sub-samples yields imprecise estimates.

¹¹Again, overall patterns are highly consistent whether using children's or women's responses about children's chores.

thresholds for amount of time spent in chores (not shown).¹² This approach also yields mixed evidence. For most sub-samples, results suggest that those who spend more time on chores are *more* likely to be in school. Regarding firewood, evidence of threshold effects is seen for younger children at 7+ hours and for girls at the two highest thresholds (6+ and 7+ hours), i.e., when spending many hours collecting firewood, they are less likely to be in school. This pattern holds using either children's or women's chore responses. Because this evidence is not causal, we do not know which came first: lots of chore hours, or leaving school.

Environmental chores and children's success in school

Enrollment is not a very strong indicator of school "success," so we also looked for evidence of systematic patterns using (1) number of days absent from school during the reference period (zero to five); and (2) usual amount of time per day devoted to homework. In this case, we use only the women's responses for the schooling measures owing to a substantial number of missing responses among children. Again, the evidence is mixed.

Table 4 shows that, among children who do not fetch water/firewood (using children's chore responses), school absences are lower. However, these findings are not as consistently observed when using the women's chore responses. Moreover, those who fetch water devote *more* time, on average, to homework. There is no association between gathering firewood and homework time in the full sample, but evidence of a negative association is seen in the results for boys. Correlation coefficients are similarly inconclusive.

Focus group results were more reflective of the patterns we expected. While it is always possible that children respond to non-verbal cues of facilitators, comments were quite consistent within age and gender groups. Girls aged 13–17 made a number of statements similar to these: *"There are a lot of domestic chores; normally I get tired and I do not have time to study"* (Village-K). *"Domestic work should be reduced so I get time to study"* (Village-M). *"A lot of work reduces the desire to study; as a result you forget what was taught the previous day"* (Village-K). *"When I get to school I only sleep, because I am tired and I can't listen to the teacher"* (Village-K). Orkin (2011) finds that fatigue is an often-overlooked dimension of children's labor force work that affects their schooling. It also shows up here in our qualitative analysis of non-labor-force work. While children clearly included water/firewood collection when speaking of domestic chores, their comments also suggest that the total amount of chores is problematic. As suggested in Tafere and Pankhurst (2015), perhaps there is a threshold effect for *all* work, including environmental chores.

Younger girls also spoke sadly about not having time to play: *"I lack playing time as well as time to do school work"* (Village-K). While playing does not directly translate into achievement in formal education, it is widely understood to be developmental for children (e.g., Woodhead, 2004). In the 1980s, Reynolds (1991, p. 64, 80) found that in the communities she studied in Zimbabwe, by age 10 girls spent almost as much time working

¹²In each case, we consider whether in-school rates differ for those above and below the threshold, utilizing progressively larger time values to define thresholds at one-hour intervals. The maximum thresholds are at least ten and seven hours per week, for water and wood respectively.

as their mothers, more than their fathers, and substantially more than their brothers. That type of pattern may explain why we did not hear similar comments from boys.

Chores for school

Given the lack of water infrastructure at schools, we asked children whether they were expected to fetch water for their schools, either during a break at school or by bringing water from home. Among the 89 in-school children in our sample, we have responses to these questions for 77. Of these, 91 percent indicated they were sometimes asked to fetch water for school and, of these, about 81 percent (74% of the total non-missing) had been asked to do so during the past week. These children were roughly twice as likely to have fetched water during the school day than to have brought it from home. Either way, it cuts into time that students could devote to school work or other activities.

Of those who fetched water for school during the week, they did so about 3.8 times on average, and fewer than 15 percent did so only once. Furthermore, the average time spent is greater than four hours, with more than half reporting at least three hours fetching water for school during the week. A number of focus group participants made comments similar to these: *“It is true that we bring water and firewood to school from our homes. We are punished if we fail to do that”* (boy 13–17). *“Some students do not attend school because of their failure to bring water and firewood to school. When we fail to bring water and firewood ... we are caned or sent to fetch water during class hours”* (boy 13–17). *“There are children who do not come to school with water; when they are told to go and fetch water, they do not show up again”* (boy 10–12).

Confounding factors

Any connections between youth’s engagement in environmental chores and educational outcomes may be confounded by a variety of other factors, as suggested by Figure 1. We briefly discuss three of these, school quality, school-related violence and water infrastructure.

School quality—The poor quality of rural education in many low-income countries, including Tanzania, is well-known. Issues include frequent teacher absence, inadequate teacher training, high student-to-teacher ratios, and lack of learning materials and infrastructure (Glewwe *et al.*, 2014). When the in-school children in our survey were asked an open-ended question, “Please tell us what the headmaster or teachers could do to improve your learning in school,” 28 responses were along the lines of:

Teachers should teach well.

Proper supervision of teachers to make sure they teach.

They should put more effort into teaching.

Focus group respondents also spoke to the need for more teachers and for reduced teacher absenteeism, as in: *“Teachers should increase efforts in teaching by attending all lessons.”* (boy 13–17). When schools are not serving children well, children are likely to spend more

time on activities that have immediate benefits, such as farming or herding, or doing household tasks.

School-related violence—It is often incorrectly assumed that schools are welcoming environments for children. Around the world, many children experience school as unpleasant or even terrifying, including, e.g., verbal, physical, or sexual abuse from other students or teachers (Harber, 2004). Of the 89 in-school children in our sample, 38 percent reported being punished at school at least once in the past week, and often multiple times. Children most often reported the following punishments: caning on the hand (n=85), caning on the buttocks (79), fetching water (46), pulling or boxing ears (44) and digging (35). In focus groups, punishment was raised as a concern by each group of boys but none of the girls. For example, boys ages 13–17 in Village-M said: “... *teachers provide harsh punishments that make some students not like schooling*” and “*To be punished by being under the table when caned makes some students hate school.*” In response to our question, “Have any other kids bullied you, either in school or going to/from school?” 43 percent of students said yes, including almost all girls. Such dynamics inevitably contribute to children leaving school, irrespective of demands on their time to perform environmental chores.

Infrastructure—There is a great deal of variation in the availability of water-related infrastructure (wells, taps, pumps) in rural Tanzania, and availability does not necessarily mean operational. Pumps and taps in sub-Saharan Africa are frequently in disrepair (Harvey and Reed, 2006; Marks, 2013¹³) and breakages may lead to unexpected increases in children’s environmental chores. Also, wells may run dry. One focus group girl’s comment indicates that even when taps work, water is not always available: “*They should open the water early so I am not late for school*” (girl 13–17, Village-M). Tracking when water is actually obtainable from various sources is another important challenge to understanding relationships between children’s schooling and environmental chores.

Conclusions

We use cross-sectional quantitative and qualitative data from two villages in rural Tanzania to gain insights about connections between children’s responsibilities for environmental chores—fetching water and firewood—and their educational success. First, we document the heavy reliance of households on children to perform these chores, especially girls and children ages 10 to 14. With respect to potential relationships with schooling, the descriptive quantitative evidence presented here is mixed, in some cases suggestive of tensions and in others suggesting a positive association between environmental chores and schooling. As in Gebru and Bezu (2014) for Ethiopia, Nankhuni (2004) and Nankhuni and Findeis (2004) for Malawi, and Ndiritu and Nyangena (2011) for Kenya, we do not find evidence of a negative relationship between children’s participation in environmental chores (when measured as a simple yes/no) and being in school. We do find limited quantitative evidence suggesting that large amounts of time devoted to environmental chores is negatively associated with school enrollment, also in keeping with the findings based on IV model estimation in the studies

¹³Marks, Sara (2013) “Applied Research for Improved Global Health: Linking Engineering to Water Policy and Practice,” presentation.

above. Finally, our quantitative evidence with respect to environmental chore participation and factors that might impact children's success in school (attendance and time devoted to homework) suggests tensions in some cases but positive associations in others. While due to limited sample size we did not explore possible threshold effects here, Nankhuni (2004) estimates a negative effect of environmental chore time on the likelihood that older children advance to upper primary school.

The qualitative data, however, suggests that effects are more subtle than we are able to capture, when tired children have more difficulty learning. Sorting out independent effects of environmental conditions from the many other potential influences on children's school participation and success is a key challenge, as we document. In addition to obvious exogenous factors such as provision and maintenance of water infrastructure by governmental and non-governmental organizations, less obvious forces include school-related violence that might greatly reduce the desirability of going to school.

The importance of this kind of study is that it points to several issues that are worthy of detailed investigation in efforts to understand linkages between schooling and the natural environment, and it can also make allies of education advocates and proponents of natural resource conservation. We encourage authors of larger-scale studies (ideally longitudinal) with a focus on environmental chores to (1) complement child/woman reporting of time use with step-counting devices for a sub-sample of children; (2) include younger children; (3) obtain school data on absences and tardiness as well as measures of literacy and numeracy, or relative success such as class rank; (4) obtain measures of school quality, while (5) also collecting data on school-related violence; (6) obtain more complete information on children's time use, including environmental chores for school, as well as on the time use of other household members; (7) consider how to capture not only village water-related infrastructure at different points in time but also its functionality from day-to-day; and (8) use GPS coordinates for wood-gathering areas, noting changes over time. An even more complex study might also incorporate water quality and child health, as many households do not purify drinking water. We believe that the evidence and arguments presented here, in concert with the studies reviewed above, support the value of such larger-scale studies.

In addition, it is essential to listen to children's own perspectives, even about fears that do not seem directly policy-related but may affect behavior. It is not possible for us to tell whether, for example, the fears reported during focus groups are seriously disturbing or mainly add the spice of adventure to a weekly outing. It is certainly possible that the further afield children have to go to find wood and water, the greater will be the perceived—and possibly actual—risks.

Using children's own responses leads to different levels but often similar patterns to those from data provided by proxy respondents, in this case mothers or female guardians. Reynolds (1991) documented similar disparities, and Dillon (2010) finds that adult proxy respondents underestimate the time that children spend in work and school, and the underestimates are larger for girls. Research in this area remains exploratory, but such potential differences should be kept in mind.

Finally, not all of children's comments about environmental chores are negative. Youth know that water and wood are absolutely necessary for family life to continue: *"I do like fetching water and collecting firewood because if we do not... we will not get firewood for cooking so we will not eat... if we do not fetch water we will not have water for cooking, washing, etc."* (boy 13–17, Village-K). *"... firewood collection is good ... because we are helping our parents..."* (boy 10–12, Village-M). The very necessity of this work creates the imperative to better understand its implications for educational outcomes.

A final caveat is that this analysis focuses on marginal changes or differences, assuming that other factors remain more or less the same. If, however, environmental conditions reached a tipping point that left villages with little water or firewood, or (for example) led to conflict or famine, children's time use and schooling would likely be fundamentally altered by migration, civil strife and other societal changes that this analysis is unable to address.

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Figure 1.
Conceptual Model

Table 1

Average Hours Spent on Environmental Chores in Past Week (for participants) and Rates of Participation [in brackets], Children Ages 10 to 17

Respondent: Column:	Fetch Water		Gather Firewood		Fetch Water and/or Gather Firewood	
	Child (1)	Woman (2)	Child (3)	Woman (4)	Child (5)	Woman (6)
Total (n=114)	5.3 [78.1%]	6.0 [76.3%]	6.5 [39.5%]	5.7 [36.8%]	8.6 [78.1%]	8.2 [81.6%]
Village K (n=60)	7.6 [78.3%]	8.3 [81.7%]	6.8 [53.3%]	5.8 [51.7%]	12.2 [78.3%]	10.9 [90.0%]
Village M (n=54)	2.8 [77.8%]	2.9 [70.4%]	5.9 [24.1%]	5.5 [20.4%]	4.6 [77.8%]	4.4 [71.2%]
Village differences	4.8**/0.6	5.4**/11.3 [^]	0.9/29.3**	0.4/31.3**	7.6**/29.3**	6.5**/24.8**
Males (n=51)	5.1 [66.7%]	5.1 [66.7%]	6.9 [29.4%]	6.3 [23.5%]	8.1 [66.7%]	6.9 [70.0%]
Females (n=63)	5.5 [87.3%]	6.5 [84.1%]	6.3 [47.6%]	5.5 [47.6%]	8.9 [87.3%]	8.9 [90.5%]
Gender differences	0.4/20.6**	1.3/17.5**	0.6/18.2**	0.8/24.1**	0.8/18.2**	2.0/21.7**
Age 10–14 (n=80)	6.0 [81.3%]	6.5 [80.0%]	6.5 [47.5%]	5.7 [40.0%]	9.8 [81.3%]	8.9 [83.3%]
Age 15–17 (n=34)	3.4 [70.6%]	4.4 [67.6%]	6.7 [20.6%]	5.9 [29.4%]	5.3 [70.6%]	6.2 [76.5%]
Age differences	2.7**/10.7	2.1 [^] /12.4 [^]	0.2/26.9**	0.2/ 10.6	4.5**/26.9**	2.8 [^] /15.7*

NOTES: Differences rows show absolute values of, and significance tests for, differences i average minutes / participation rates, between pairs of villages, genders, and age groups.

Significance levels: ** significant at 5% using a 2-tailed test;

* significant at 10% using a 2-tailed test;

[^] significant at 10% using a 1-tailed test.

Participation and Time (for participants) in Environmental Chores by In-School Status, Children Ages 10 to 17

Table 2

Respondent:	Fetch Water			Gather Firewood		
	% Participation		Average Hours	% Participation		Average Hours
	Child	Woman	Child	Woman	Child	Woman
Total (n=114)						
In school	80.9	80.9	5.4	6.0	44.9	42.7
Not in school	68.0	60.0	4.8	5.5	20.0	16.0
Village K (n=60)						
In school	78.0	84.0	7.8	8.4	56.0	54.0
Not in school	80.0	70.0	6.4	7.5	40.0	40.0
Village M (n=54)						
In school	84.6	76.9	2.6	2.7	30.8	28.2
Not in school	60.0	53.3	3.5	3.8	6.7	0.0
Males (n=51)						
In school	65.7	68.6	5.6	6.0	37.1	31.4
Not in school	68.8	62.5	3.9	3.1	12.5	6.3
Females (n=63)						
In school	90.7	88.9	5.4	6.1	50.0	50.0
Not in school	66.7	55.6	6.6	10.4	33.3	33.3

Table 3
Percentage in School by Environmental Chore Participation, Children Ages 10–17

Respondent	Fetch Water				Gather Firewood				
		Child		Woman			Child		Woman
		Yes	No	Yes	No		Yes	No	
Total	(n=114)	80.9	68.0	82.8	63.0	88.9	71.0	90.5	70.8
Village K	(n=60)	83.0	84.6	85.7	72.2	87.5	78.6	87.1	79.3
Village M	(n=54)	78.6	50.0	79.0	56.3	92.3	65.9	100.0	65.1
Males	(n=51)	67.7	70.6	70.6	64.7	86.7	61.1	91.7	61.5
Females	(n=63)	89.1	62.5	90.6	60.0	90.0	81.8	90.0	81.8
Age 10-14	(n=80)	90.8	86.7	92.2	81.3	94.7	85.7	96.9	85.4
Age 15-17	(n=34)	54.2	40.0	56.5	36.4	57.1	48.2	70.0	41.7

Percentage Distribution of School Performance Measures by Participation in Environmental Chores, In-School Children Ages 10 to 17

Table 4

Total (n=89)		Days Absent from School (last week)			Usual Hours per Day on Homework			
		0 days	1-3 days	4-5 days	0 min.	<1 hr.	1 hr.	2+ hrs.
Fetch Water	Yes	61.1	25.0	13.9	26.4	4.2	41.7	27.8
	No	78.6	14.3	7.1	35.3	5.9	35.3	23.5
Gather Firewood	Yes	55.0	30.0	15.0	27.5	5.0	37.5	30.0
	No	71.7	17.4	10.9	28.6	4.1	42.9	24.5
Males (n=35)								
Fetch Water	Yes	56.5	30.4	13.1	47.8	0.0	21.7	30.4
	No	80.0	20.0	0.0	41.7	0.0	41.7	16.7
Gather Firewood	Yes	46.2	46.2	7.7	53.9	0.0	23.1	23.1
	No	75.0	15.0	10.0	40.9	0.0	31.8	27.3
Females (n=54)								
Fetch Water	Yes	63.3	22.5	14.3	16.3	6.1	51.0	26.5
	No	75.0	0.0	25.0	20.0	20.0	20.0	40.0
Gather Firewood	Yes	59.3	22.2	18.5	14.8	7.4	44.4	33.3
	No	69.2	19.2	11.5	18.5	7.4	51.9	22.2

NOTES: School performance measures are based on women's responses.
Chore participation is based on children's responses.