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**Environmental Degradation and Household Welfare:
The Case of Moc Chau District, Son La Province, Viet Nam**

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Acknowledgment

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<u>Abstract</u>

This research paper was designed to measure and analyze the impacts of environmental degradation on children's educational attainment and household welfare in selected villages of the Van Ho Hamlet, Moc Chau District, Son La Province of Viet Nam. Its main objectives were to test whether (i) children's educational attainment and (ii) household income from collecting environmental products were affected by the deteriorating environmental resources situation in the studied areas.

This research used two empirical econometric models and found that (i) there were other factors that significantly affected the probability of school attainment for the schoolchildren and that environmental degradation, based on the estimates, did not have any significant impact on the children's education attainment; and (ii) household income from collecting environmental products significantly decreased with an increase in the household size. However, the decrease was insignificant with an increase in household wealth and with the degree or severity of environmental degradation. These findings indicate that severely degraded environment and household wealth had negative impacts on household income among families collecting environmental products. With these findings, it implies that policymakers could focus more on other relevant factors excluded from the study model, such as school crowding, illness, bad weather, and other issues when formulating appropriate school policies. For the local or central government to fund the learning facilities, the growth of the economy is an important aspect. Policymakers, thus, need to formulate overall strategies that would guarantee high growth rate for the economy in both the medium and long term, which in turn will increase the budgetary allocation for the education sector especially for rural and mountainous areas, to fund education for children and to increase the chances of improving the economic status of rural households.

1. Introduction

In many rural and mountainous areas of developing countries like Viet Nam, forests and woodlands still form a large part of the local environmental resource base. Forests and woodlands provide benefits to people of nearby societies to sustain their livelihoods (Dasgupta 2001). Reliance on local resources shared by the communities or commons is prominent in semi-arid and mountainous regions (Chopra et al. 1990). It has been pointed out that this reliance is a reflection of the low standard of living in these areas (Cavendish 1999). For example, the World Bank (1996) notes that local communities in many parts of Sub-Saharan Africa (SSA) depend more heavily on their local environmental resource base than in any other region in the world. Moreover, SSA has experienced severe land degradation, deforestation, lack of access to safe water, and substantial loss of biodiversity resulting in an even lower standard of living.

In reality, rural households in most developing countries depend quite heavily on surrounding environmental products such as water, fuelwood, vegetable and fruits, and livestock fodder. At present, these environmental products are more difficult to obtain and collect under currently degraded conditions that lead to scarcity of environmental products. In addition, rural households in developing countries have fewer feasible alternatives for livelihood. They are, therefore, greatly compelled to spend increasingly more time on and use more labor for collecting scarce environmental products from common forests and woodlands as their way of earning income while environmental products become scarcer under environmentally degraded conditions. This way of earning income may considerably affect household labor allocation, children's education, labor efficiency and productivity, environmental degradation, household income, and poverty reduction. Environmentally degraded conditions also lead to diminished environmental products. Thus, this affects the income of households in these areas.

As in many other developing countries in the world, many parts of Viet

Nam have been experiencing a deteriorating environmental situation. One of these is the rural and mountainous northwestern part of the country. In this region, especially in areas where ethnic minority people like the H'Mong, Tay and Nung, and other groups reside, households of about 20 percent of the provinces in this region depend heavily on the surrounding environment for livelihood.[1] Environmental products from the surrounding common forestlands are the main sources of their income. The Moc Chau District in Son La–a northwestern province of Viet Nam, an area where mostly H'Mong people reside, is the district selected for this study as many households in most of its villages have few feasible alternatives for livelihood. Of these few alternatives, they chose to collect scarce environmental products from common forests and woodlands, such as fuelwood, wild vegetables and fruits, wild forest products that can substitute as food, and many other products as their way of earning income. This way of earning income requires them to spend more time and use more labor (including that of schoolchildren), aside from causing severe environmental degradation, which in turn affects the livelihood and income of people living nearby. It is argued in this study that this type of livelihood has close links with environmental degradation and to children's education, while environmental degradation is closely related to the livelihood of the people residing nearby. Thus, this study aims to explore and analyze the impacts of environmental degradation on children's education and households' welfare (household income) in Van Ho Hamlet, Moc Chau District of the Son La Province in Viet Nam.

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[1] This statement is based on the results of a survey conducted by the research team, combined with information collected from the General Statistical Office of Viet Nam.

2. Research Objectives

This study looks into the problems of environmental degradation and its impacts on household income and on children's education. It seeks to test the following hypotheses:

(i) The household welfare (household income in this study) is inversely affected by deteriorating environmental resources, and

(ii) The school attendance and progress of children in rural primary schools is adversely affected by deteriorating environmental resources.

The problem of environmental degradation in rural and mountainous regions of Viet Nam is alarming. According to some studies by the World Bank and by Vietnamese researchers, the livelihood of around 20 percent of the population in the northwestern villages of the country is heavily dependent on surrounding environmental products (VEPA 2001). There are many factors that contribute to the environment degradation in this area (VEPA 2003 and 2004), but the livelihood and earnings of the local and indigenous peoples are the most significant factors in the context of this study. However, due to time and budget constraints, this study is confined only to two very important impacts of deteriorating environmental resources, namely (i) impacts on primary school educational attainment (children's education), and (ii) impacts on household welfare (household income). The overall objective of the study is to examine and analyze the impacts caused by declining environmental resource base due to environmental degradation particularly on children's education and household welfare (income) in the Van Ho Hamlet, Moc Chau, Son La of Viet Nam.

The main focus of this study is to assess the impacts of environmental degradation on children's education and on household welfare (household income). The children's education is measured in terms of the schoolchildren's time devoted to education or the education record of children in school. Household welfare is expressed in terms of household income. This study attempts to address several research questions, such as: (i) How is children's education affected by environmental degradation (or by deteriorating

environmental resources)? (ii) What are the impacts of environment degradation (or by deteriorating environmental resources) on household welfare (household income)?

3. The Study Area

Moc Chau, a district of Son La Province with its famous dairy farm Moc Chau, is situated 1,050 meters high above sea level and located about 200 km northwest of Hanoi. Moc Chau has an area of 2,025 square kilometers (km^2) and with a population of 15,000 at a density of 69 people per km^2. Moc Chau district consists of two district-level towns and 27 hamlets. The district is home to the 13 ethnic minority groups - Thai, H'mong, Kinh, Lao, Hoa, Khmu, Dao, Tay, and others. Moc Chau is famous for its mild temperature and has a well-known place - the Plateau Moc Chau - which attracts many tourists all year round.

This study covers areas of the Van Ho hamlet, which is adjacent to the Moc Chau town. Most people living in the studied area belong to the ethnic minority group called H'mong. In the studied areas, six villages were selected for intensive interviews. These villages reflect the best example of environmental degradation. Observations and pre-study assessment showed that people's livelihood in the hamlet is partly dependent on forests and woodlands resources, as well as on environmental products.

Van Ho is a mountainous hamlet of the Moc Chau district that reaches up to 1,050-meter altitudes and covers about 80 km^2 in area. Some 48 percent of the hamlet's area is covered by forests and woodlands. The hamlet's population is around 8,000, consisting of many ethnic minority groups but the majority comprises the H'mong people (around 60%). The study area is located at the upland plateau near the famous Moc Chau where many dairy and tea farms are located. The income-generating activities of the residents in the hamlet are agriculture and forestry where the main crops are maize, paddy and dry rice, fruits, and other forest and woodland products. The villages selected for the survey are Bo Nhang I, Bo Nhang II, Pa Che I, Pa Che II, Suoi Lin, and Pa Cop.

The livelihood of the people living in the study area is heavily dependent

on the seasons and surrounding environment as these are agriculture- based. During the dry season, they earn more from collecting forests and woodlands products but these sources of income decline as the rainy season arrives (VEPA 2002, 2005). For households that were interviewed in this study, apart from their income from agricultural activities, their other sources of income include selling environmental products collected from forests and woodlands and other nonagriculture activities. All these characteristics of the study area are representative of the selected hamlet and villages for the interview.

4. Literature Review

Many studies have been conducted on the issue at the international level. Of these studies conducted, a large number have highlighted the essential nature of indigenous woodlands in providing livelihood for the poor households (Bradley and McNamara 1993; Arnold 1995). Also, there have been some empirical attempts at assessing the household labor allocation decisions and common property resource used by formally modeling household production system. Amacher et al. (1993) developed a household production model to explore household production and demand for fuelwood and fuel substitutes in two different mid-hill districts of Nepal. The study reveals that women and children are significant collectors for households that rely on community forests for their fuelwood (Cooke 1988). Some studies have also paid attention to the effects of scarcity of environmental products other than fuelwood (Kumar and Hotchkiss 1988; Bluffstone 1995; Mekonnen 1998), while a number of studies have focused on determinants and impacts of the deteriorating environmental resources on people's livelihoods although these studies remain silent on the implications of environmental degradation on household labor allocation, welfare, and well-being.

Environmental degradation and children's education

Child labor literature surveys show that children in Africa and Asia have higher labor force participation rates than children in any other part of the world (Grootaert and Patrinos 1999; Canagarajah and Coulombe 1997). Theories of

human capital (Becker 1993; Mincer 1974) show that time allocation for children to work or to go to school has long-term implications for their future ability to contribute to economic growth and development, as well as to their economic status. Therefore, children's time allocation choices have long-term implication for economic development of African and Asian countries, particularly the developing and less-developed countries in these regions, including Viet Nam.

Most of the analyses of child labor and schooling have been conducted on the effects of formal child labor on education. Examples of these studies include Rosenzweig and Evenson (1977), Psacharopoulos and Arriagada (1989), and Psacharopoulos (1997). One of the welfare impacts of child labor is educational attainment. There is no general consensus on the negative effects of formal child labor on schooling. Some studies find that child labor is detrimental to schooling (Jensen and Nielsen 1997; Patrinos and Psacharopoulos 1997), while others find it not detrimental (Binder and Scrogin 1999) for school performance, and Skoufias (1994) finds a positive relationship between child wages and schooling.

However, in some parts of Africa and Asia, it has been estimated that at least 70 percent of child labor takes place in private homes. Therefore, it is logical to include domestic child labor for household benefits in studying the welfare impacts of child labor. Few studies have quantified the effect of domestic child labor on schooling (Levison et al. 2001; Ilahi 2001; Levison and Moe 1998). The study of Lloyd and Gage-Brandon (1994) presents results suggesting that Ghanaian girls are disadvantaged due to their role in childcare responsibilities in large families, but children's labor was not modeled directly. Grootaert (1999) combined formal work and housework in her definition of child labor and found it to be negatively related to schooling in Cote d'Ivoire. However, domestic work was not modeled separately in the Grootaert (1999) study. Abler et al. (1998) studied the effects of formal as well as domestic work on children's education in Peru and found domestic work to be a greater deterrent to children's schooling than formal work. Binder and Scrogin (1999)

found results contradicting Abler et al. (1998). Although both formal and household work had a small negative effect on human capital formation hours (hours in school and extracurricular activities), their main finding was that formal work is associated with reduced leisure for children. They also found that neither formal nor domestic work hours had significant negative effects on measures of academic performance (grades attained and children's desired schooling).

Gender-specific effects of work on schooling were reported in a study in Egypt by Assaad et al. (2001) and a study in Mexico by Levison et al. (2001). The Egyptian study found that girls' education was negatively affected by work when a broader definition of work was used to include domestic work,[2] while boys' education was not. The same study also shows that the way work is defined has a significant impact on the effects of child labor for girls, while for boys, a narrow definition of work to include only market work, does not change the effects of work on schooling. The study by Levison et al. (2001) in Mexico found similar results: a broader definition of work resulted in girls' education being negatively affected by work, while a narrow definition (incorporating only market work) seemed to suggest that girls are advantaged in schooling opportunities. The study also found that the presence of a mother was advantageous to both boys and girls but particularly to girls because they benefited more from the mother's presence to do domestic work.

Few studies have specifically looked at the effects of environmental degradation on children's education. However, some studies in the child labor literature can be interpreted as showing some evidence of the effects of the environment on education. For example, Orazem and Gunnarsson (2004), and Psacharopoulos and Arriagada (1989) found that the existence of piped water was the strongest predictor of school enrollment in Brazil and that it also had substantial positive impact on school attainment levels (more years of schooling attained and reduced dropout rates). Psacharopoulos and Arriagada (1989) took

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[2] Their domestic work excluded firewood collection but included cooking, errands, house cleaning, collecting water, doing the laundry, and child care.

the availability of piped water as one of the proxy evidence of the impact of environmental degradation on school attendance. That is, children who do not have a close source of water are disadvantaged in school enrollment as well as in school performance. An explanation for this would be the greater amount of time that these children had to spend on water collection. Psacharopoulos and Arriagada (1989) explained that this variable could also be reflecting location attributes, that is, communities with piped water are also likely to have more public schools and other social facilities. However, this result can also be interpreted as evidence of the impact of environmental degradation on school attendance where children without a close source of water are disadvantaged in school enrollment as well as in school performance. One explanation for this would be the greater amount of time that these children had to spend on water collection.

Nankhuni (2004) specifically looked at the effect of environment-related work on children's education and investigated whether long hours of work spent by children in fuelwood and water collection activities - i.e., natural resource collection work - influence the likelihood that a child between 4 and 14 years old attends school. She applied two-stage conditional maximum likelihood on the data from 1997 to 1998 of the Malawi Integrated Household Survey conducted by the Malawi National Statistical Office in conjunction with the International Food Policy Research Institute (IFPRI). The study found that Malawian children are significantly involved in resource-collection work and their likelihood of attending school decreases with increased hours allocated to this work. The study further showed that the presence of more women in a household is associated with a lower burden of resource-collection work among children and a higher probability of children's school attendance. Finally, the research showed that children from the most environmentally degraded districts of central and southern Malawi were less likely to attend school and relatively fewer of them have progressed to secondary school compared to those from districts in the north.

No similar study to that of Nankhuni (2004) linking environmental

degradation to children's education has been conducted in Viet Nam. Three studies - Akabayashi and Psachropoulos (1999), Al-Samarrai and Tessa (1998), and Mason and Khandker (1996) - however, were concerned, not with the impact of environmental degradation on child schooling but with the related effects of formal labor on human capital formation in some rural areas of Viet Nam.

Akabayashi and Psachropoulos (1999) investigated the degree of trade-off between child labor and human capital formation using time-log data of children from a Tanzania household survey. This study found that a trade-off between hours of work and study existed, and hours of work tended to be more affected by social conditions than hours of study. Hours of work were negatively correlated to reading and mathematical skills through the reduction of human capital investment activities, indicating a trade-off between child labor and human capital. The results indicated the complexity of the issue and the need for detailed time allocation data.

However, many other studies were conducted that linked and correlated environmental degradation with that of child education, such as the study by Khanam and Russell (2005), and the relationship between schooling and educational attainment (Maitra 2003), but no such study had been conducted in Viet Nam so far. Thus, this paper seeks to bridge this literature gap on these issues in Viet Nam. It especially looks at the impacts of environmental degradation on children's primary education in selected hamlets of Van Ho, Moc Chau in the province of Son La.

Environmental degradation and household income

This section provides an overview of the linkage between the state of environmental degradation and household material welfare (e.g., standard of living including household income).

The environmental degradation could refer to the processes of land degradation, deforestation, deterioration of aquatic systems, lack of good quality water, environmental pollution, and loss of wildlife habitats and biological

diversity (FAO 2003). These are also the six major environmental problems the world faces today (USEPA 2000). Of these six, the most prevalent ones in Moc Chau, Son La are land degradation, deforestation, loss of wildlife habitats, and lack of accessible good quality water.

In this study, standard of living refers to material issues only, such as income, wealth, and goods (Antonides and van Raaij 1998). Household is defined as a group of people living in the same dwelling and sharing at least one meal a day (Lind 2000). This household definition refers to the nucleus of two biological parents of opposite sex and at least one child. In this study, the household is taken as the unit of analysis because it is the locus where resources are generated, organized, managed, used for economic activities, and for generating the welfare and care for the household members (Niehof 2002).

Household material welfare is multidimensional, with many constituents and determinants closely determined by the quality of the environment (Duraiappah 2004). However, not all constituents may be under serious threat and not all of these constituents are directly dependent on the state of the environment. Therefore, only constituents and/or determinants of household material welfare directly affected by the quality of the environment are elaborated in this section.

Land degradation is a phenomenon resulting from a mixture of natural and human processes. It is a progressive process that starts with the loss of vegetative cover, exposing soil surfaces to the erosive power of wind and rain. However, the processes of land degradation are varied (Chuwa 2002). Its severity can be assessed from the red-brown color of streams and in floods as the topsoil is washed away from upland areas (MTNRE 1994). Other manifestations of land degradation include loss of fertility, bareness of the topsoil in many fields, and silting of dams and reservoirs. Land degradation has been a major threat to agricultural development. It reduces yield directly via poor seedling establishment, water logging, and crop burial (Semgalawe 1998). Indirectly, land degradation affects crops through lack of nutrients (nitrogen, phosphorous, and potassium) and organic matter, moisture deficiency, and

general deterioration of the structure of the soil (Lal 1985).

Around 50 years ago, Moc Chau, Son La was endowed with enormous environmental resources and favorable climatic conditions that offered opportunities for development. At that time, most parts of Moc Chau were still covered with natural forests. Many parts of the arable land were uncultivated, covered with natural vegetation (VEPA 2003, 2004). Land was owned by the state's cooperative. Shifting cultivation and fallow practices were the main methods used by the H'Mong people living in the areas. This method of cultivation used by the people maintained land fertility. Farmers cultivated the virgin land for two years and left it, then opened up new land to allow soil regeneration. Thus, land during this time was not degraded and cultivated land was not scarce.

After Viet Nam's victory over the United States (US) that ended the Viet Nam - US war, the population started to increase at a very fast rate. As population increased, more people migrated from other parts of the country to Moc Chau as the area was favorable for agricultural activities, making the region more crowded and more land being cultivated. By the 1980s and 1990s, almost all arable lands were under cultivation. Between 1975 and 1990, the annual population in Son La grew by 3.7 percent, which was higher than the country's national average of 3.2 percent. This rate included both natural birth rate plus the migration rate. Thus, after 1980, the pressure on land became severe, leading to arable land scarcity. In response to increased land scarcity at the mountains, farmers acquired lands in the lowlands for cultivating annual food crops, mainly maize, beans, and rice. Also, in trying to meet their increased land needs, farmers resorted to cultivating very steep slopes; and began to encroach into forests, valley bottoms, and wetlands, which served key roles in the protection of the environment. People started to clear parts of natural forests for crop production, livestock grazing, settlements, and fuelwood (FAO 1971). As a result of these practices, most of the land cover was removed. Formerly big rivers like Song Da (Da River), and Song Ma (Ma River) that run through the region started to dry up or to decrease in water volume, especially during the dry

season.

Overgrazing also accelerated land degradation. People of mountainous areas in the northwestern part of Viet Nam kept large numbers of cattle to graze on the hills and fields. During the 19th century (1886), the western slopes and plateaus in the region were covered with grasses and made good pasture areas, and were extraordinarily abundant with cattle. In the last few decades, cattle, goats, and horses ate and trampled down the young trees while herdsmen slashed and burned vegetation to open up new pastures. The movement of stock also led to the destruction of vegetation cover along their routes. With increased grazing pressure, soil erosion had become widespread. The rapid growth in animal numbers had resulted in shortage of grazing land, and animals grazed on steep slopes where cultivation was difficult. This had led to soil compaction and increased surface runoff. Many plants had also been trampled down, leaving the land bare and increasing the development of rills and gullies.

Today, Moc Chau in particular and Son La province in general experience land degradation. Soil productivity has been considerably reduced in many areas. Although soil erosion is, to some extent, a natural process, it has been greatly accelerated by human activities, and by poor cultivation practices and poor livestock keeping (Semgalawe 1998). Vertical ploughing across steep slopes, failure to adopt crop rotation, failure to maintain adequate vegetative cover, inadequate use of organic fertilizer, and lack of sufficient conservation measures, particularly on hill slopes, have all led to declining soil productivity and crop yields. All these factors are deeply rooted in the socioeconomic development and knowledge of people. Factors like poverty, insecurity of tenure, and loss of traditional conservation practices and of indigenous resource knowledge, in general, all underlie the whole process of land degradation in the area. Consequently, among others, the economy, which is agriculture-based, is performing poorly while people tend to out-migrate to nearby areas where there are still available natural forests and lands, and where they continue to slash and burn new arable lands, further destroying the surrounding environment (VEPA 2005).

Moc Chau, Son La has also been experiencing deforestation problems that resulted in a decrease of areas with forest covers. The loss of a forest does not decrease with increasing altitude. In higher-altitude highlands where the catchment forest reserves are typically found, only some of these forest reserves have been protected, much the same way as those on the lower slopes. This means that the majority of the forest losses in Moc Chau has not only occurred in the lowlands, but also recently at higher-altitude lands (Department of Agricultural and Forestry of Moc Chau 2005).

Table 1: Description of forest covers in Moc Chau

Location	Natural forest (km^2)	Number of forest matches	Closed forest (km^2)	Loss of original forest cover (%)
Moc Chau	587	20	168	49
Bo Nhang I	16	4	-	55
Bo Nhang II	24	5	8	61
Pa Che I	19	3	9	45
Pa Che II	28	8	11	72
Suoi Lin	32	6	7	68
Pa Cop	22	7	7	52

Source: Author's calculation, based on data from the Moc Chau Statistics Office, 2010.

Although the local average rate of annual deforestation in the area has yet to be computed, the national average annual deforestation rate is alarming. Between 1976 and 2000, Viet Nam lost an average of 200,000 hectares of forest per year. This led to an annual average deforestation rate of close to 1.2 percent. Between 2000 and 2010, the rate of forest change decreased to 1.1 percent per annum. The deforestation rate of 1.1 - 1.2 percent is higher than the world's average deforestation rate of 0.21 percent (VEPA 2003, 2005). This high rate of deforestation is caused by the (i) population growth creating pressure on cultivated land (FAO 2003), (ii) dependence of population on fuelwood as a source of energy (FAO 1990), (iii) overgrazing, (iv) commercial felling of

timber, and (v) clearing forests and woodlands for industrial use (mainly for village industries, such as brick burning). Deforestation is also accelerated by forest fires. Apart from population growth, commercial felling of timber and fuelwood as a source of household energy in the study area deserve some in-depth explanation. Commercial felling of timber refers to unsustainable illegal logging practiced in the Moc Chau reserve forests. A survey by the Department of Agriculture and Forestry of the Moc Chau District (2005) revealed that there were over 100 pit saw sites found in the areas, more than 30 sites of which were active and operating on the day of the survey. Fieldwork in Moc Chao showed that an average of 3 - 5 trees were cut per day without replacement at each site. This average figure was used to generate an estimated range of 330 - 550 trees logged out from the over 100 pit saw sites in Moc Chau alone. The removal of hardwood from the forest was inefficient and wasteful, with pit sawyers taking a small portion of the felled tree and leaving the majority of the trunk and harvestable wood untouched. Up to 30 smaller trees were cut at each pit saw site to support the logging camp (these smaller trees were chopped down to create an open workspace and to make the platform for sawing). This created large canopy gaps in the forest where the effects were probably too sunny for forest species to recolonize, turning the area into a degraded habitats of tangled weeds.

The survey by the Department of Agriculture and Forestry of Moc Chau (2005) also revealed that wood collection in the forests and mountains of Moc Chau is one of the major causes of deforestation. In this study, firewood is defined as woody biomass used for fuel without processing, in contrast to charcoal. Fuelwood or wood fuel is a category that covers both firewood and charcoal (Johansen 1999). To earn for a living, ethnic people in the Moc Chau district and in the six villages under this study collect firewood and wood fuel, which contributed to the deforestation and caused environmental degradation in the area that, in turn, negatively affected their livelihood.

Finally, no such study similar to that of Nankhuni (2004), which linked environmental degradation to children's education, and studied the relationship between environmental degradation and household welfare, had yet been

conducted in Viet Nam. However, there are several studies that focused on identifying the extent of environmental degradation in the country, such as the studies by Nguyen (2006), and Peter and Pham (2000). Other studies attempted to examine environmental deterioration due to the shifting cultivation method by ethnic minority groups in the northern provinces of Viet Nam. However, no systematic study has yet been attempted to fully address the issues on the impacts of deteriorating environmental resource bases on children's education and on household welfare (or household income), thus, there is very little empirical evidence on the effects of environmental degradation on household labor allocation, on children's allotted school time, and generally on subjective welfare and well-being of households in Viet Nam. Thus, this study will attempt to analyze and examine the impacts of deteriorating environmental resource bases on children education, and household welfare for the case study of the Moc Chau District, Son La Province of Viet Nam. On the whole, this study attempts to analyze the impacts of degradation of forest and woodland environment on household income in Van Ho hamlet, Moc Chau district, Son La province in Viet Nam.

5. Methodology

The study employed two different frameworks, as follows:

Model to Assess and Analyze the Impacts of the Deteriorating Environmental Resources on Children's Education

In this study, the primary school educational attainment was used to measure the impacts of the deteriorating environmental resources on children's education. The variable indicating school progress is referred to as "educational attainment," implying progressing at the right age for attending appropriate school levels in the school system. In the literature,[3] one frequently used measure of school attainment is the *SAGE* (*Schooling-for-Age or Grade-for-Age*). *SAGE* is calculated using the procedure proposed by Patrinos and Psacharopoulos (1997) given as

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[3] See Orazem and Gunnarsson (2004), Khanam and Russell (2005), Maitra (2003), and Orazem and Gunnarsson (2003).

$$Grade-for-Age = 100 * \left[\frac{Grade \, or \, class}{Age - E} \right]$$

where *E* represents the country-specific usual school age (which is six years in Viet Nam). *SAGE* will, therefore, measure school attainment relative to age. A score of less than 100 indicates that the child is falling behind in education. Consequently, all those with a score under 100 are considered as having below normal progress in the school system. The formula for *SAGE* as proposed by Patrinos and Psacharopoulos (1997), however, presents several issues when using data in the Viet Nam context on young children. For children who are in their first year of schooling, a strict interpretation of *SAGE* will give an infinitive value since the denominator equals zero (since *Age-E=0*). Further, if the child starts school before he/she reaches the minimum age, then *SAGE* potentially can be greater than 100. In this case, then *E=6* cannot be used for the entire sample in constructing *SAGE,* which automatically leads to loss of information. If *E=6* is used, then *SAGE* will take negative values for five year-old children, and infinitive values for six year-old children. For the purpose of estimation therefore, in this study, the formula for educational attainment variable is modified into discrete ordered variable, which is obtained using the following formula:

$$Sage = (Grade - Age) + (E - 1) \tag{1}$$

Because the compulsory entry age in Viet Nam is 6, the educational attainment formula becomes *SAGE=Grade – Age + 5*. It follows then that *SAGE = 0* implies "on time" school progress; *SAGE > 0* implies "ahead" of normal school progress; and *SAGE < 0* indicates "falling behind."

The literature[4] also recognizes schoolchildren as producers and consumers of commodities who participate in household and agricultural production, and during their schooling and leisure time. Schooling is a commodity whose grade attained (*SAGE*) is subject to time allocated to education T_c, household characteristics that affect child education, e.g., ethnicity Z_c, individual

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[4] Muller (1976) and Caldwell (1990).

characteristics like gender, age, age squared, parents' educational level, occupation, and others. F_c, represents household income I, household size H, market-price school goods G_c, environmental quality E, and the interactions.[5] The square of the age is included to account for any non-linear age effects. Thus, the equation *(1)* is re-proposed as:

$$SAGE = c(T_c, Z_c, F_c, I, H_c, G_c, E, E*I)$$ (2)

where the subscript c is restricted to characteristics that affect school attainment exclusively.

The environmental quality E may affect the children's education through its effect on the productivity of time in the household production function. For instance, if the environment is more degraded, children will have to spend more time on environmental product collection and/or grazing at the cost of their schooling. That is the number of hours that children spend on resource collection and/or grazing, which is associated with the likelihood of reduced school attendance, supporting the hypothesis that resource collection work has a negative influence on schooling.

The equation *(2)* was estimated using ordered probit estimation techniques, and the estimation results were used to interpret the relationship between children's education and environmental degradation (with other supporting variables that may affect the whole relationship).

Model to Assess and Analyze the Impacts of the Deteriorating Environmental Resources on Household Welfare

A model was developed to estimate the impact of environmental degradation on household income. The idea for forming this model stemmed from the fact that many households in the studied areas depend heavily on surrounding environments for earning income. That income may come from collecting wood, water, food, wild vegetables, wild fruits, and many other items available in woodlands and forest that people could collect than sell in the market for money. Thus, to effectively measure household income from

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[5] The interaction of the environmental degradation situation and the logarithm of the total household income.

collecting environmental products, income from main sources, such as from agricultural activities, wages, and other nonagricultural activities were deducted.

Thus, the household income from collecting environmental products is measured by the following equation:

$$I_E = I_{TT} - I_A - I_w - I_o \qquad (3)$$

Where, I_E is household income from collecting environmental products including fuelwood, wild vegetables and fruits, and other forest and woodland products that can be used as food, such as honey, wild animals, and others, which can be sold to generate income; I_A is income from agricultural activities; T_W is income from wages; and I_O is income from nonagricultural activities other than wage.

Also, I_E can be calculated from all sources of income from collecting environmental products, which sums up all kinds of incomes, such as income from collecting firewood (I_{WO}); income from collecting water (I_{WA}); income from collecting wild vegetables (I_{WV}); income from collecting wild fruits (I_{WF}); income from catching fishes from streams, rivers, and ponds/lake (I_F); and income from grazing and cutting grass to feed animals (I_G). I_E can be represented as follows:

$$I_E = I_{WO} + I_{WA} + I_{WV} + I_{WF} + I_F + I_G \qquad (4)$$

Equation 4 represents components of the income from collecting environmental products. In the process of earning such income as discussed above, a household has to utilize all sources of labor, including children of school-going age collect firewood, vegetables, and fruits; catch fishes; oversee grazing; and related activities. Thus, income from collecting environmental products depends on various factors representing household characteristics (H_c), parents education (P_e), time spent by schoolchildren to collect environmental products (T_s), environmental condition dummy (degradation level) (E_d), household wealth dummy (W_d), and household consumption (H_s). These are

represented by an equation relationship, as follows:

$$I_E = f(H_c, P_e, T_s, E_d, W_d, H_s) \qquad (5)$$

According to functional relationship (5), income from collecting environmental products depends on various factors representing environmental degradation level, such as time spent by children in collecting the products (T_s), environmental degradation level (E_d), and household consumption (H_s). The more an environment is degraded, the more the time spent by children in these activities as products become scarce. The dummy variable for environmental condition takes a value of *0* if the environment is not degraded, *1* if the environment is medium degraded, and *2* if the environment is severely degraded. Household wealth dummy takes two values: 0 if the household is regarded as poor and *1* if the household is non-poor. Also, if a household consumes more, children have to spend more time collecting environmental product. Consequently, it would affect more their education records. To examine the impacts of environmental degradation on household income, equation *(5)* was regressed using the ordinary least square (OLS) method.

Data Sources and Types

Two sources of data were used for the analysis - one from archived sources and the other from the survey to be conducted. However, the study was meant to rely mostly on the survey data at household level.

➢ *Archived source*: Data were provided by the District and Hamlet Statistical Office. This source provided information on socioeconomic conditions, demographic and geographical data, as well as the general environmental conditions of the selected villages. The statistics included data on household income, sources of income, and children's educational attainment.

➢ *Surveyed data*: The study used cross-section primary data from a survey conducted for the research. The sample consisted of households composed of couples with at least one schoolchild who is at primary

school and partly participates in household work or work in the field. The sample selection and the survey conducted enabled the analysis of the time taken by children to collect environmental products as a source of household income, and how this affected the children's school time and school records. The survey was structured so as to collect information about, among others, household composition, income, assets, human capital, and time allocation to various productive activities and leisure, especially the time allocated for children to work in the field or to do housework at home.

To analyze how variation in the environmental resource base affects intra-household labor allocation, especially the child labor allocation and thus may influence child education, three categories were identified: severely degraded, medium degraded, and non-degraded environments. To control for variations in other factors, the sampling strategy ensured that the selected areas are as similar as possible with the represented areas - socially, economically, demographically, and physically. Potentially, such areas can be found in the northern provinces of Viet Nam, especially in many villages in Van Ho, Moc Chau, Son La, the selected site for the survey and research. These areas share highly similar climatic conditions and topographies, which over time, have resulted in having communities relatively similar in terms of economic activities, demographic profiles, and many other social aspects, such as children's education, their needs, and others.

The study used a stratified sampling technique for sample selection, guided by district, ward, and village officials. Data collections were done in two stages. The first stage involved a pilot survey of 10 households to pretest the survey instruments, get a better understanding of the study area, observe the environmental situation prevailing in the area, and the socioeconomic characteristics of the households. This helped to refine the scope of the research problem, identify any major information gap, and design and prepare the main survey. Pretest questionnaires were also critically examined for cultural and language conformability.

With the help of local authorities, the main survey that employed the stratified random sampling procedure was conducted in six villages.[6] At least 25 households from each village were selected for a total of 150 households. The questionnaires[7] were administered to 150 heads of households (husbands or wives or both answered the questions) and at least one schoolchild in each household, with the help of the local authority at the village level.

Information were gathered on five general areas: (i) household characteristics, (ii) environmental (forests and woodlands) products collection, (iii) agricultural production system, (iv) household income (sources), and (v) children's (primary) education. Information collected included household size, age of family members, their gender, educational level, and their relationship to the household head; fuel wood, water and grass collection and utilization patterns; major crops, yield, and consumption; and incomes. As both agricultural and home activities are affected by the seasons, care was taken to consider seasonal allocation of family labor during the year that would affect the results of the study. All information collected and gathered have been processed to suit the form that could be used for model estimation and analysis.

6. Data Analysis

Household Characteristics of Studied Areas

The Van Ho hamlet consists of 15 villages with 1,745 households and a total population of 8,164, of which 4,124 are females. There are five ethnic minority groups living in the hamlet namely Kinh, Thai, Muong, H'Mong, and Dao. The selected study site consists of six villages in the Van Ho hamlet, Moc Chau district, Son La province. These villages are Bo Nhang I, Bo Nhang II, Pa Che I, Pa Che II, Suoi Lin and Pa Cop. Table 2 presents the structure and characteristics of the population of Van Ho and the six selected villages.

Table 2. **Population and demographic characteristics of 6 villages, Van Ho**

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[6] A three-stage sampling procedure was adopted. First, over 15 villages were sorted out by a stratification technique, using population, number of households, state of environmental degradation, and geographical zone as parameters. Second, from among those 15 villages, six were selected for the household survey. Lastly, the households were randomly selected according to the a-priori set criteria of a household having at least a child in his/her primary school age and having participation in earning income for the household.

[7] The questionnaires were prepared in Vietnamese, the national language, to avoid translation discrepancies among the enumerators during the interviews.

No.	Hamlet	No. of households (Total population)	By Ethnic Group				
			Kinh	Thai	Muong	H'Mong	Dao
1	Total for Van Ho	1,745 (8,164)	314 (1,031)	27 (99)	342 (1,051)	930 (4,845)	232 (1,138)
2	Bo Nhang I	164 (846)	14 (56)	1 (3)	-	149 (787)	-
3	Bo Nhang II	104 (485)	24 (70)	1 (1)	-	79 (414)	-
4	Pa Che I	95 (472)	3 (6)	-	-	91 (461)	-
5	Pa Che II	39 (217)	3 (10)	-	-	36 (207)	-
6	Suoi Lin	111 (515)	-	1 (1)	-	-	110 (514)
7	Pa Cop	146 (756)	5 (13)	-	1 (4)	140 (739)	-

Source: Van Ho Municipality.

Note: Numbers in parentheses represent the total population.

Figures provided in Table 2 reveal that the majority of those living in Van Ho are H'Mong people (more than 59.4%), followed by the Dao (13.9%), the Muong (12.9%), the Kinh (12.6%), and the Thai (1.2%). The statistics indicate that Van Ho is the home for the H'Mong people. In all the six villages, most of the people belong to the H'mong minority group - comprising 79.24 percent of their total population. Based on Table 1, the average household size in the Van Ho hamlet is 4.7 persons. Of the five major ethnic minority groups, the H'mong people have the largest household size with 5.2 persons per household, on average.

The average per capita income of a household in Van Ho is around USD 700 in 2011. This level of per capita income is quite low compared to the national average, which is around USD 1,200 (2011 figure at 2009 price). This proves that Van Ho is rather a poor hamlet in Moc Chau in particular and in Viet Nam in general.

On the education of households heads, the survey revealed that out of the 150 household heads, 23 (15.3%) completed high school, 30 (20%) completed

secondary schools, 51 (34%) finished primary school, and the remaining 46 (30.7%) did not complete primary school. No household head had a university or college degree suggesting that no household head in the surveyed areas continued education after finishing high school.

Survey Results

Education in Van Ho is currently given priority for development as more budgets have been invested to improve school facilities and the living standard of teachers and education practitioners. During the period 2010-2011, a priority program for kindergarten and primary education improvement has been implemented. As a result, almost 100 percent of villages in the hamlet have kindergarten schools and a group of village has one primary school, helping children to be able to go to school. Van Ho is a quite remote area, distance between villages is rather far, and hence, it is difficult for primary students to go to the central hamlet school. According to the 2011 statistics provided by the hamlet's municipality, 98 percent of children under 6 years old go to kindergartens in the hamlet while 100 percent of school-age children are registered to attend primary school education. These figures indicate the high rate of children going to school in Van Ho. However, during their five years of primary education, there are numbers of children who have dropped out and many have to repeat their school levels.

Table 3: **Results of the household survey**

No.	Criteria/Variable	Mean (Std. Dev.)
1	Time allocated for education (school hours per week including time spent in school and at home)	35.26 (11.76)
2	Average age for starting school (year)	7.21 (3.18)
3	Father's primary education	3.87 (6.49)
4	Father's secondary education	7.54 (7.23)
5	Mother's primary education	3.05 (7.47)
6	Mother's secondary education	6.06 (8.45)
7	Household annual income* (million dong)	62.76 (0.367)

8	Household size (number of persons)	6.2 (6.86)
9	Hours spent on household work per week	9.38 (5.88)
10	Leisure hours per week	79.18 (4.89)
11	Household's time for water collection per week (in hours spent)	11.24 (4.65)
12	Household's time for fuelwood gathering per week (in hours spent)	7.50 (4.04)
13	Proportion of children who attended school in the past 12 months (percentage)	89 (4.02)
14	Proportion of children who regularly missed school (percentage)	75.4 (12.76)
15	Proportion of children who never missed school (percentage)	22.6 (8.19)

Std. Dev. = standard deviation.
 * = the figure used is at 2009 price.
Source: Author's calculation based on the survey data.

Of the sample of 150 households with schoolchildren, one child represented each household. As shown in Table 3, the criteria used for selection were primarily their familial relationship to the household head, their physical ability to perform various activities, including collection of grass feeds and/or overseeing grazing and other agricultural and household works, were enrolled at primary schools, and were able to express themselves. Children who were living together with their biological parents were preferred in this survey. Of the 150 children, 90 (60%) were boys and 60 (40%) were girls. In general, 89 percent of these children reported that they attended school in the past 12 months while 11 percent reported they did not. The 11 percent who did not attend had either permanently or temporarily dropped out of school. In any case, if they would attend school next academic year, they would have to repeat the grade level. Among those who attended school in the last 12 months, some missed school occasionally apart from holidays and school breaks, with 2.0 percent reported to have missed school quite often, 75.4 percent missed school regularly, and 22.6 percent who never missed school during the whole academic year.

For time allocated to education, a child in primary school in Moc Chau

spent only five hours per day on average, including both at school and at home, for study. Usually, the time required at school is four hours per day. This is low compared with the national average of 6 hours spent by a child per day for their education (Ministry of Education and Training of Viet Nam 2009). The average age for starting school in Moc Chau is higher (at 7) than the national average of 6, and the average parent's educational attainment is quite low at Grade 5. Household income is also lower than the national average, and the average household size is rather large at 6.2.

The survey revealed that around 60 percent of children participated in household work, worked in the fields, and spent time to collect forest and woodland products, such as fuelwood, wild vegetables and fruits, herbs, and other valuable items available in forests. When the children were asked how all these affected their schooling and school records, around 80 percent responded that these kinds of work somehow affected their school records and school attendance. Survey results also revealed that some 20 percent of primary school students dropped out during their five years of primary education. Of this proportion, 2 percent stopped at Grade 1, 4 percent left school at Grade 2, 3 percent at Grade 3, 6 percent at Grade 4; and 5 percent stopped at Grade 5. Their reasons for leaving school are as follows: (i) parents could not afford their education; (ii) student could not follow program due to lack of intelligence and due to the complexity of the program (in their perception); (iii) they need to help their parents with household chores and to work in the fields, such as oversee grazing, and to collect forest and woodland products to earn income for their families.

Household Income and Environmental Conditions

On household income in the studied areas, the main sources are from agricultural activities (100% of interviewed households answered "Yes" to this question), forest and woodland products, and other nonagricultural activities. According to the survey, household income from collecting environmental product is at a declining trend in recent years. The increased degree of

environmental degradation resulted in the scarcity of forest and woodland products.

At present, the environmental condition in Van Ho is rather degraded, somehow affecting the livelihood of people around the areas. Land degradation is obvious as annual crops became less productive. Deforestation is alarming as statistics from the Department of Agriculture and Rural Development of Moc Chau indicate that over the past five years, the forests in Moc Chau in general and Van Ho in particular declined by around 30 percent. As a result, the fuelwood and forest products in the hamlet became scarce. This reality affects the income of households living in Van Ho, and indirectly affects the living standard of the people in this area.

Based on the archived and surveyed data, the household incomes in Van Ho were affected by the state of the surrounding environment. Survey shows that among the various sources of household income, those from collecting environmental products is important to around 30 percent of the surveyed households. The family's source of living is dependent on how much fuelwood, wild vegetables and fruits, and other products that parents and children could collect and sell for money to buy food and other foodstuffs. However, respondents revealed that this source of income has been declining in recent years as surrounding environmental condition started deteriorating due to the overexploitation of land, grazing, and deforestation. As survey results showed, people now have to spend more time collecting forest, woodland, and environmental products. This, in turn, affected people's time allotted for work at home, in school, and at the fields.

7. Empirical Results and Discussion

Deteriorating Environmental Resources and Children's Primary Education

Equation (2) was estimated using ordered probit technique. The dependent variable is primary school attainment. The ordered probit technique was used because the dependent variable, which is primary school grade attained by children, is an ordinal variable that indicates a ranking of school attainment that

takes more than two outcomes.[8] Also, this was used because the value of such an ordered school progress is arbitrary and is a function of a set of explanatory factors as described in Equation (2). The independent variables are environmental degradation - at various stages of degradation - and used as dummy variable. The medium degraded dummy takes the value of 1 if the environment is severely degraded and 0 if otherwise, 1 if the environment is medium degraded and 0 if otherwise. The degree of environmental degradation is a subjective perception of the people residing in the studied areas.

As shown in Table 4, based on the estimation results of the model presented in Equation (2), the probability of educational attainment at primary school was found to be significant when associated with age, age squared, and the mother's secondary education. Households belonging to the H'Mong group, as compared to other groups, insignificantly decreased the probability of progress at primary education. The father's basic education at the primary and secondary education level, the mother's primary education at a lower significant level or no significant level, the hours spent on schooling per week, and the probability that children would progress at school are not significant. Interestingly, environmental degradation - both in severe and medium-degraded situations - had no significant impact on children's educational attainment. Thus, environment degradation and time spent collecting scarce environmental products proxied by the average kilograms of fuelwood, wild vegetables and fruits, and liters of water used in households per week had no significant effect on the school attainment of children in studied areas. This is not surprising, however, because according to the survey, children spent, on average, the same number of hours per week in school activities across villages under study with different environmental conditions.

Both the age of the schoolchild and the age-squared are statistically significant. This implies that there was a significant non-linearity in the effect of age of the child on school attainment, decreasing after the age of 6.7 years. That is, the older the child, the more she/he lagged behind in school. However,

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[8] Primary education in Viet Nam consists of five grades - from Grade 1 to Grade 5.

environmental degradation situations did not impact much on these delays because the collection of environmental products, their work at home, and their work in the fields - each contributed less than or equal to 5 percent only to the children's school attainment.

The mother's literacy level generally had a positive effect and is statistically significant on the educational attainment of the schoolchildren. While the mother's secondary education attainment significantly increased the probability of the children's progress at school, the basic literacy of the mother at the primary education level increased the education attainment of children, but not statistically significant. Surprisingly, the father's literacy (both primary and secondary education) had negative effects on children's education. Mothers with secondary education are favorable to schoolchildren's education because culturally children are traditionally closer to their mothers at the age of primary education. A mother is a person to follow and to tutor their children during this age. In the studied areas, most women are working in the fields so they have little effect on children's education, and by tradition, people from ethnic groups seem to prefer working in the fields than going to school as most households need hands in labor work more than education. Young boys below 16 years old are also encouraged to get married as a way to have more lands for cultivation and additional labor for their family. This practice negatively affects the education of children in Moc Chau.

Table 4: Estimation results: Ordered probit: Dependent variable: Primary school attainment

Variable	Coefficient	Std.err.
Medium degraded dummy[a]	*-0.026*	*0.31*
Severely degraded dummy[a]	*-0.065*	*0.45*
Age	*0.67*	*0.26****
Age-squared	*-0.045*	*0.01****
Ethnicity (Father) (H'Mong) dummy	*-0.50*	*0.40*

Father's primary education	*-0.08*	*0.53*
Father's secondary education	*-0.22*	*0.59*
Mother's primary education	*0.74*	*0.61*
Mother's secondary Education	*1.86*	*0.69****
Log hours on schooling per week	*0.11*	*0.96*
Log hours on household work per week	*0.17*	*0.48*
Log leisure hours per week	*0.04*	*0.40*
Log household water in liters per month	*0.40*	*0.38*
Log household fuelwood in kg per week	*-0.35*	*0.33*
Log household size	*0.15*	*0.56*
Log total annual income	*0.01*	*0.03*
LR x^2	255.17	
Prob > x^2	0.000	
Pseudo R^2	0.270	
N	150	

Legend: * $P < 0.1$; ** $P < 0.05$; *** $P < 0.01$; [a]= reference category: Non-degraded.
Std.err. = standard error.
Source: Author estimation using Equation 2

Other indicators, such as household size and household income, have positive impacts on children's educational attainment at primary education with no statistical significance. This is in conformity with the reality in ethnic households with more members - children are able to go to school since with more household members to work in the fields, school-age children are free to go to school. Likewise, households having more income allow children more chance to get an education compared to those with lesser income. Household income is generally a combination of income from agriculture, nonagriculture, and other sources, including selling environmental products used by households such as water, fuelwood, and wild vegetables and fruits collected from forests

and woodlands. Thus, the impact of household income on children's educational attainment at primary school may not reflect the fact that children spend more time in collecting environmental products in exchange for income that could affect their education. As earlier indicated, income from collecting environmental products in the studied areas accounts for 30 percent of household income.

This study tested whether school attendance and progress of children in rural and mountainous primary schools are inversely affected by deteriorating environmental resources. Findings reveal that there are other factors that significantly affected the probability of school attainment for the schoolchildren apart from environmental degradation, be it medium degraded or severely degraded situation. Environment degradation did not have a significant impact on children's school attendance and progress in primary education. This is because (i) children on average spend the same number of hours per week in school activities in different villages with different environmental conditions; (ii) deteriorating resources, environmental products collection, work at home, and work in the farm - each contributed only marginally to the reason why children entered late in primary school. Regression results showed these factors have non-significant effect on the children's education.

Regression results provided in Table 4 showed satisfactory explanatory power for educational attainment, the Pseudo-R^2, however, may be improved in future studies by adding school crowdedness, illness, bad weather, and others, along with the poor quality of some primary schools, perceived as equally important factors for the children's late school entry, and consequently, for the delay in their school attainment. Hence, it may be suggested that education in Moc Chau is also associated with poor health (illness), while school absenteeism may be due to the poor quality of some primary schools. Poor school quality refers to the low teacher-pupil ratio (that is, shortage of teachers), teachers' incompetence, and shortage of learning facilities such as books, school desks, proper classrooms, and others - all of which characterize Viet Nam's rural and mountainous areas. These schools are funded by both local and central

governments. Policymakers, therefore, are urged to focus on these other relevant factors that were excluded from this study's model if they intend to improve educational attainment and human capital formation at primary levels in Viet Nam. For the local or central government to fund the improvement of school facilities, the growth of the economy is critical and important. Policymakers will thus need to formulate overall strategies to achieve high growth rate for the economy in both the medium and long term that, in turn, will increase the budgetary allocation for the education sector for both recurrent and capital expenditures. At the moment, government resources committed to education are low. Meanwhile, the nongovernment sector may also be enticed to invest in education through attractive fiscal incentives.

Deteriorating Environmental Resources and Household Income from Collecting Environmental Products

In this section, the relationship between environmental degradation and household income were analyzed based on the estimated results using Equation 5. According to functional relationship in the equation, income from collecting environmental products depends on various factors representing environmental degradation levels, such as time spent by children in collecting the products (T_s) and environmental degradation level (E_d). The more the environment is degraded, the more time is spent by children collecting environmental products as these products become scarcer. Thus, environmental degradation is presented by environmental condition. The medium degraded dummy takes the value of *1* if the environment is severely degraded and *0* otherwise, *1* if the environment is medium degraded and *0* if otherwise. The variable - household wealth (W_d) - is argued that if a child was born in a wealthier family, he/she may spend less (or no) time collecting environmental products, and will have more or all their time spent in *schooling activities*. Household wealth dummy takes two values: *0* for the case if the household is regarded as poor and *1* if the household is nonpoor. Other factors that (may) pose some impact on the relationship between environmental degradation and household income are household characteristics (H_c), and parents education (P_e). Household characteristics variable, as presented

in Equation 5, is the household size. For the parents' education, the secondary education dummy was used, which takes the value of *1* if parent was at secondary education and *0* if the parents are illiterate (or no education attained). For the variable Household consumption (H_s), this study argues that if a household consumes more, children of that household would spend more time to collect environmental products. Thus, time devoted for *schooling activities* would be affected, and as a result, school record would also be negatively affected. Household consumption were valued in monetary terms per month. All the variables, those presented as household characteristics in Equation 5, would improve the explanatory power of the model.

To examine the impacts of environmental degradation on household income, equation *(5)* was regressed using the ordinary least square (OLS) method. The results are provided in Table 5.

Table 5. Environment degradation and household income: OLS estimation results (dependent variable: household income)

Variable	Coefficient	Standard Error	T-statistic
Medium degraded dummy[a]	*0.03*	*0.08*	*0.3752*
Severely degraded dummy[a]	*-0.06*	*0.10*	*0.651*
Secondary education dummy[b]	*0.23*	*0.09[**]*	*2.512*
Household wealth dummy[c]	*-0.09*	*0.17*	*-0.5294*
Log household size	*-0.11*	*0.06[*]*	*-1.8334*
Log household consumption	*0.05*	*0.02[**]*	*2.516*
Log time spent	*0.12*	*0.07[*]*	*1.7143*
Adjusted R[2]		*0.18*	
N		150	
Degree of freedom		*143*	

F-value	*4.956*
Pr>F	*0.000*

- ➤ ** p < .1;   ** p < .05;   *** p < .01*
- ➤ *[a] = reference category: Non-degraded*
- ➤ *[b] = reference education level is "illiteracy"*
- ➤ *[c] = reference category: Poor*

Results presented in Table 5 show that the household income from collecting environmental products significantly increased with an increase in household consumption, education of parents, and time spent by children to collect environmental products. For the variable *household consumption*, when a household consumes more, it needs more income. Meanwhile, income from other sources like land cultivation, raising of livestock, and others, except those from collecting environmental products, are limited so this demand induces households to find more income from collecting environmental products to offset income shortage and to meet household demand. For the variable *parents' education*, this is quite complicated to explain as in general, parents with higher education would get more income from other sources than collecting environmental products. In fact, higher education for parents among these minority groups is just Grades 6 and 7. With these levels of education, they may know how to collect environmental products better than households having parents with lower education, hence, they may earn more income from this activity. For the variable *time spent by children to collect environmental products*, this is very clear—if children spent more time, they would collect more products and get more income. Results also revealed that household income from collecting environmental products significantly decreased with an increase in household size. This finding may be difficult to explain as normally, with a bigger household size, there would be more labor that can be used for economic activities, including collecting environmental products. In this case study, households with larger size may include more dependents, such as elderly and children, who cannot work to collect environmental products. However, results showed that household income from collecting environmental

products insignificantly decreased with an increase in household wealth and despite a severely degraded environment. This finding is very clear as wealthy households do not need to earn income by collecting environmental products, and they are not affected by a severely degraded environment, which leads to the scarcity of environmental products. Results also indicated that severely degraded environment and household wealth insignificantly but negatively impacted the household income from collecting environmental products. This finding is in conformity with the practices, data from the survey, and the data from the Moc Chau's Department of Statistics, which confirm that households living around severely degraded environment tended to fall back into poverty or their wealth decreases over the time. The findings also indicated that households with more members (bigger household size) seemed to get less income from collecting environmental products.

The coefficients of the parameters of household consumption, time spent by children, and parents' education were positive and significant at either *P < 0.1; P < 0.05 or P < 0.01*, respectively. The variable of household consumption was average quantity of money spent for daily living by the household per month. ariable *time spent by children* is calculated as the sum of time a child spent on collecting environmental products per month. All the findings indicated that in areas where environment was more degraded, the household's income was negatively impacted as income from collecting environmental products decreased. Further, with a more environmentally degraded environment, children spent more time collecting forest products to be able to contribute to household's total income. Finally, a secondary education attained by parents had a significant positive effect on household income that came from collecting forest products, which meant that expectation was high for a parent with education of at least secondary level - those households with more educated parents would earn more from collecting forest products. This may be contradictory to the fact that children with more educated parents would spend less time in the field and in collecting forest products. This may indicate that income from collecting forest products would be contributed more by adults (as

parents in the household).

This section attempted to measure the impacts of environmental degradation on household income that came from collecting environmental products. To the best of our knowledge, this is the first study of its kind in Viet Nam. The results and ideas are still inconclusive, and more analyses still need to be done. Among others, these include *(i)* an operating definition of income for developing countries like Viet Nam where the concept "income" is not well-defined, particularly in rural areas; *(ii)* testing for endogeneity of income and other explanatory variables; *(iii)* examining whether personal and household characteristics of the respondent and those of the household enter the welfare and income function; and *(iv)* solidifying the exact variables that fit both the welfare and income functions in a developing context. Thus, for this work to be done, the analysis of the estimated results from Equation 5 would be more convincing and would bring more policy as well as theoretical significance.

8. Discussions, Conclusions, and Policy Recommendations

Many parts of rural and mountainous regions in Viet Nam are experiencing a deteriorating environmental situation. Causes of environmental degradation are cited as population growth, deforestation, poor farming techniques, and weak forestry regulatory frameworks. Of particular importance is the disappearance of forests and woodlands. Some of the consequences are declining amounts and diminished frequency of rainfall.

Deteriorating environmental resources increases the cost of collecting environmental products, which in many aspects have no feasible close substitutes. One of the major components of increased cost is labor time allocated by household members (especially children at primary education level) to collecting environmental products. This reallocation of household labor resources may have different effects on welfare (income) for a household. In less developed communities like those in Moc Chau, the degradation of the local environmental resources base is expected to adversely affect poor households. Furthermore, labor time allocation may interfere with labor allocated to other

agricultural activities in the area. It could drain much of the time children allocate to schooling activities, which may have negative implication on their school performance and in the quality of their human capital in the long run. Lastly, household labor resource allocation may influence the economic welfare (income) of households.

Very few studies have identified the extent of environmental degradation in Viet Nam.[9] Also, very few studies have paid attention to the effects of scarcity of environmental products other than fuelwood (Kumar and Hotchkiss 1988; Bluffstone 1995; Mekonnen 1998). These studies remain silent on the implications of environmental degradation on children's primary school progress and on household welfare/income. This study, therefore, presents an empirical analysis of these effects in Moc Chau, thus, complementing other studies in the field.

The analyses were based on data collected in 2012 from a survey of households in Moc Chau, Son La province of Viet Nam, and from the statistical data of the statistical yearbook of Moc Chau district and Son La province. The area is identified as having been relatively dependent on environmental products for the people's livelihood.

Children's Educational Attainment and Environmental Condition

Research results showed that the probability of educational attainment at primary school was found to be significantly associated with age, age-squared, and the mother's secondary education. Households belonging to H'Mong ethnic group, as compared with other groups, insignificantly decreased the probability of progress at primary education. On the mother's secondary education level, which is at a lower significant level or no significant level, the probability that children would progress at school are highly significant. Interestingly, the environment's degraded situation had no significant impact on the children's educational attainment. Thus, in the study sample, environment degradation and the time spent collecting scarce environmental products proxied by the average

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[9] Please refer to the literature review in this study.

kilograms of fuelwood and liters of water used in households per week had no significant effect on the school attainment of children in the studied areas. This is not surprising, however, because based on the survey, children spent, on average, the same number of hours per week in school activities across villages under study with different environmental conditions.

Both the age of the schoolchild and the age-squared are statistically significant. This implies that there was a significant non-linearity in the effect of age of the child on school attainment, decreasing after the age of 6.8 years. That is, the older the child, the more she/he lagged behind. However, the environmental degradation situations did not impact much on these delays because the environmental products collection, work at home, and work on the field - each contributed less than or equal to 5 percent only to the school attainment of children.

The mother's literacy level generally had a positive and statistically significant effect on the educational attainment of the schoolchildren. While the mother's secondary educational attainment significantly increased the probability of the children's progress at school, the basic literacy of the mother at the primary education level increased the educational attainment of children, but not statistically significant. Surprisingly, the father's literacy (both primary and secondary education) had negatively affected the children's education but not statistically significant. The schoolchildren's education was favored by mothers with secondary education because, culturally, children are naturally and traditionally very close to their mother and is the person to follow and tutor the children during their time of primary education. In the studied areas, most women are working in the fields so they have little effect on the children's education as traditionally, people from ethnic groups seem to prefer working in the fields than studying at school especially since most households need additional labor more than education. Many young boys even below 16 years old are encouraged to get married as a way of acquiring more labor for the family. This practice negatively affects the education of children in Moc Chau in general and in the studied areas in particular.

Other indicators, such as household size and household income, have positive impacts on children's primary education with no statistical significance. This is conformity with the reality among ethnic groups where households with more members allow children to go to school since there are more people working in the fields for the family, hence, schoolchildren need not work in the fields. Likewise, households with more income allow children greater chance to go to school compared with those having less income or are poorer. The household income is generally a combination of income from agriculture, nonagriculture, and other sources, including those derived from selling environmental products used by households, such as water, fuelwood, and wild vegetables and fruits collected from forests and woodlands. Thus, the impact of household income on children's educational attainment at primary school may not reflect the fact that children spend more time collecting environmental products in exchange for income that could affect their education. As noted earlier, income from collecting environmental products in the studied areas makes up 30 percent of household income.

Household Income and Condition of Environmental Resources

Results showed that household income from collecting environmental products significantly increased with an increase in household consumption, education of parents, and time spent by children collecting environmental products. Results further showed that neither household consumption, parents' education, nor household size directly influenced the household income. Results also revealed that household income from collecting environmental products significantly decreased with an increase in household size. However, household income from collecting environmental products insignificantly decreased with an increase in the degree of environmental degradation (severely degraded) and in household wealth. The findings also indicate that severely degraded environment and household wealth have insignificant and negative impact on the household income from collecting environmental products. These findings conform with the perception that households living nearby or around severely degraded environments tended to fall back into poverty or their wealth

decreased over time. The finding also indicated that households with more members (bigger household size) seemed to get less income from collecting environmental products.

The coefficients of the parameters of household consumption, the time spent by children, and the parents' education were positive and significant at different probability. In addition, findings also showed that in areas where environment was more degraded, the household's income was negatively impacted even if the source of income from collecting environmental products decreased. If the environment is degraded, children spent more time collecting forest products that will contribute to their household's total income. Finally, the parents' secondary education had a significant positive effect on household income from collecting forest products. This means that expectation is higher for a parent with at least secondary level of education—such that a more educated parent would earn more from collecting forest products. This may be contradictory to the fact that children by more educated parents would spend less time in the fields and in collecting forest products. This may also indicate that more income from collecting forest products would be contributed by adults (as parents in the household).

Conclusions and Policy Implications

This study tested whether school attainment and progress of children in primary school and household income in selected villages in Moc Chau District of Son La Province were inversely affected by the deteriorating environmental resources.

On the impacts of the deteriorating environmental resources on children's educational attainment, research findings show that there were other factors that significantly affected the probability of school attainment for the schoolchildren, apart from the degraded environmental conditions - be it in medium degraded or severely degraded situations. Environmental degradation, as revealed by the estimation, did not have significant impacts. Two main reasons were identified. First, all children spent, on average, the same number of hours per week in

school activities across environmental conditions. Second, despite deteriorating environmental resources, the collection of environmental products, grazing activities, work at home, and work in the fields - each of these contributed only marginally (less than or equal to 5%) to the school attainment of children.

On the impacts of deteriorating environmental resources on household income, study results revealed that household income from collecting environmental products significantly decreased with an increase in household size. However, household income from collecting environmental products insignificantly decreased with an increase in household wealth and despite severe environmental degradation. This means that a severely degraded environment and household wealth have negatively impacted on household income that came from collecting environmental products. This finding conforms with the perception that households living near or around severely degraded environments tended to fall back into poverty or their wealth decreased over time. Households with more members (bigger household size) seemed to get less income from collecting environmental products.

Policy Implications

This research project, which focused on measuring the impacts of environmental degradation on children's education and household welfare, has the following policy implications:

(i) The research findings suggest that the government should consider the patterns of household labor allocation (especially schoolchildren labor) to make sure that these relate to changing environmental conditions. It is suggested that policies for the protection of environmental resource base are formulated to ensure that the welfare of ethnic minority groups living in mountainous areas are protected. Thus, policies for proper local forest resource management need to be looked into, formulated, and implemented as appropriate.

(ii) The findings suggest that the government of Viet Nam should formulate proper policies for sustainable agricultural development in order to protect the surrounding environment in rural and mountainous areas in Viet Nam. This is of

great importance in the overall promotion of sustainable environment while protecting the welfare of ethic minority peoples in these regions of Viet Nam.

(iii) Based on the research findings, it is recommended that environmental policies be developed and implemented in order to help reduce the negative impacts of environmental degradation on productivities in agriculture and, in the long run, on investment in human capital.

(iv) The findings suggest that policy recommendations on improving education for children in ethnic minority groups in rural and mountainous areas of Viet Nam be made in order to increase awareness among ethnic people on the need to protect their surrounding environment, which will in turn ensure better welfare protection, improved education, and sustainable livelihood in the long term.

Further, policymakers are urged to focus on the other relevant factors excluded from this study's model in their efforts to improve children's educational attainment and human capital formation. Both the local and central governments need to find ways to fund the improvement of the learning facilities, which could only come with a corresponding growth of the country's economy. Policymakers, thus, need to formulate overall strategies that would bring in high growth rate of the economy in both the medium and the long term, which in turn, will increase the budgetary allocation for the education sector to fund both recurrent and capital expenditures. At the moment, government resources that are committed to the education sector are low. Meanwhile, the nongovernment sector may be enticed to invest in education through attractive fiscal incentives.

In addition, the poverty alleviation program should also be made to work effectively to guarantee households especially those with children at primary school age. As the findings revealed that environmental degradation, at various degrees, did not have a significant impact on children's education, policymakers should now focus on the other relevant factors excluded from this study's model, such as school crowdedness, poor health and illness, bad weather, and

other related issues. With appropriate overall strategies that could improve the country's economy in both the medium and the long term, this will provide the chance for improving children's education, increasing household wealth, and improving the citizens' welfare.

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