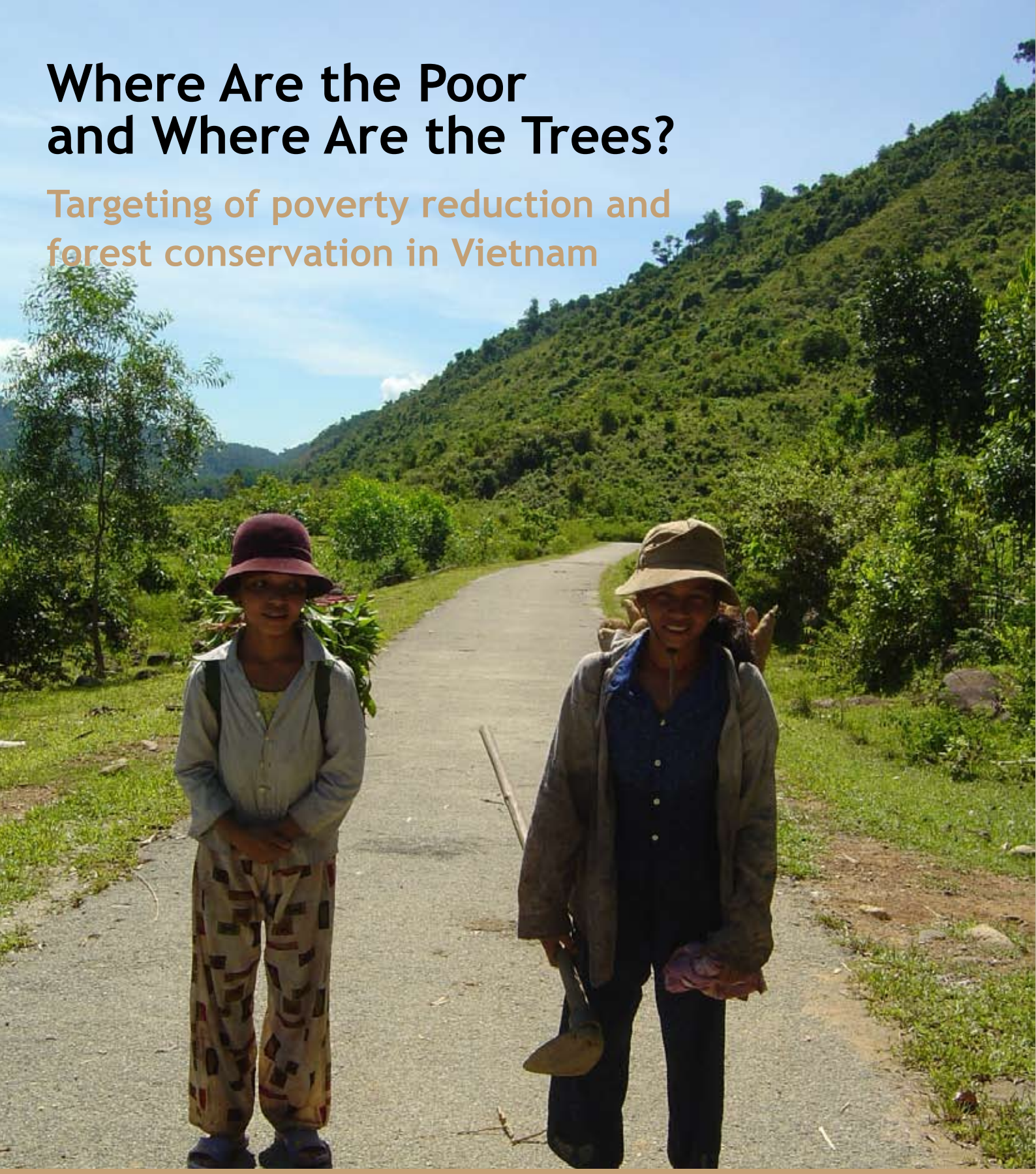
Where Are the Poor and Where Are the Trees?

Targeting of poverty reduction and forest conservation in Vietnam



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Targeting of poverty reduction and forest conservation in Vietnam

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Contents

Abbreviations

ADB	Asian Development Bank
GDP	Gross domestic product
GIS	Geographic Information System
GSO	General Statistical Office of Vietnam
IDS	Institute of Development Studies
IFPRI	International Food Policy Research Institute
Lao PDR	Lao People's Democratic Republic
LISA	Local indicators of spatial association
MDG	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
P_0	Poverty incidence (or rate or headcount)
P_1	Poverty gap
P_2	Poverty severity
PHC	Population and Housing Census
VDG	Vietnamese Development Goals
VLSS	Vietnam Living Standards Survey
VND	Vietnamese Dong

Preface

In the last two decades Vietnam has made a remarkable achievement in reducing poverty in both urban and rural areas. Over the same period, it has made strides in the direction of slowing deforestation and restoring forest cover, and protecting biodiversity.

In this brief paper we contribute a perspective on how to balance plans for a further decline of remaining poverty with concurrent improvement in forest conservation and management. Our contribution focuses on a description of the strong patterns of association between the location of poor people (and relatedly, other types of poverty measures) and the location of remaining natural forests in Vietnam. The paper focuses on measurement and analysis of these patterns at the commune level using geographic data sources for both poverty and forest. We give a graphical overview of the relationships between the two, but are well aware that the policy implications of these patterns of association require further elaboration than this paper can provide.

We hope that - in particular - policy makers and planners in Vietnam responsible for poverty alleviation and natural resource management will find our paper interesting and useful. We welcome any comments or questions that you may have. Please direct your communications to Daniel Müller (d.mueller@rz.hu-berlin.de).

The authors
January 7, 2006

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Abstract

This paper highlights the spatial linkages of forest quality with poverty incidence and poverty density in Vietnam. Most of the Vietnamese poor live in densely populated river deltas and cities while remote upland areas have the highest poverty incidences, gaps, and severities. Forests of high local and global value are located in areas where relatively few poor people live, but where the incidence, gap, and severity of poverty are strongest, and where the livelihood strategies are based on agricultural and forest activities.

Analysis was conducted combining country-wide spatial data on commune-level poverty estimates and the geographic distribution of forest quality. The results suggest the usefulness of targeting investments in remote areas that combine poverty reduction and environmental sustainability.

Keywords: Forest cover; poverty incidence; poverty density; spatial correlation; Vietnam.

1. Introduction

World leaders put poverty eradication and sustainable development at the heart of the global agenda through the formulation of the Millennium Development Goals (MDGs). The MDGs were endorsed by 189 countries at the United Nations Millennium Summit in 2000 (Poverty and Environment Initiative 2002). Increasing concerns about the linkages between poverty and environmental degradation are also evident in the first Millennium Ecosystem Assessment (MEA). This document analyzes options for enhancing the conservation of ecosystems and their contributions to human well-being (Millennium Ecosystem Assessment 2003; 2005). This paper assesses the relationship among environmental and welfare measures in Vietnam by highlighting the commune-level linkages of human well-being, narrowed down to a commonly used definition of economic poverty, and forest cover as one indicator for ecosystem quality.

The Vietnamese government began implementing the Vietnamese Development Goals (VDG) in 2002. Following the MDGs, the VDGs encompass both poverty reduction and environmental targets. Vietnam's ambitious socioeconomic development targets for 2010 include a 40 percent reduction of the proportion of people living below the internationally accepted poverty line and a 75 percent reduction of people living under the internationally accepted food poverty line (Socialist Republic of Vietnam 2002: page 120). To ensure environmental sustainability, one of the key indicators to monitor progress towards the VDGs is the planned expansion of forest cover from 33 percent in 1999 to 43 percent in 2010. These objectives of the Vietnamese government are stated in the Comprehensive Poverty Reduction and Growth Strategy, authorized by the Vietnamese government in 2002 (Socialist Republic of Vietnam 2002).

In this paper we explore the linkages between measures of poverty estimated at the commune level and forest conditions as one proxy for the natural environment. Forest-poverty linkages are investigated using the official forest cover data set for Vietnam combined with small-area estimations of poverty incidence. The empirical insights are drawn from map comparisons, correlation mapping, and visual descriptive statistics.

In the next section, we describe the data sources used to estimate poverty in Vietnam, giving attention to the methodology of poverty measures and national trends in poverty incidence. Further, we compare the most recent commune-level poverty incidence data with poverty density. Section three presents the forest cover data as of 1999. The relationships between the poverty measures and forest quality are examined in section four at the level of country aggregates and also at the commune level. In the concluding fifth section we summarize the findings and discuss policy implications.

2. Poverty measures in Vietnam

The official poverty measure employed by the General Statistical Office (GSO) of Vietnam is the poverty incidence, that is, the percentage of people living below the national poverty line. The Vietnamese poverty line is based on the expenditures required to purchase the equivalent of 2,100 Kcal per person per day using the food basket of households in the third expenditure quintile, plus a non-food allowance corresponding to the non-food expenditures of these households. The poverty line is equal to 1,789,871 Vietnamese Dong (VND) per person per year,[1] plus adjustments using price indices to compensate for differences in the cost of living over the course of the survey and across regions (Minot *et al*. 2003). The use of expenditure data is an advantage as it takes account of the income contribution of forest-related activities to the expenditures figures.

This measure of poverty incidence, also termed poverty rate or poverty headcount, reduces the broad concept and multi-dimensional nature of poverty to a single, one-dimensional measure of "welfare-poverty" based on estimated expenditure (Reardon and Vosti 1995). We do not have information on "investment-poverty" that describes the ability to avoid resource degradation and to invest in resource enhancements (Reardon and Vosti 1995). We are aware of this limitation. On the other hand, there are compelling reasons why the measure of expenditure poverty still serves its purpose regardless of its narrowness. It is easy to understand and to communicate, and it can help in assessing progress in monitoring poverty reduction (Ravallion 1992).

Vietnam achieved a remarkable reduction of food poverty as well as income poverty in the last decade. The country-wide poverty rate or poverty incidence, measured as the percentage of the total population below the national poverty line, also referred to as P_0, decreased by 21 percent between 1993 and 1998, and by another 8 percent until 2002 (Figure 1). The poverty gap index, also called P_1, measures the proportional expenditure deficit of an individual below the poverty line multiplied by the poverty incidence. P_1 dropped from 19 to 7 percent of the population between 1993 and 2002. Vietnam's success in reducing poverty is directly related to national economic growth dating from the late 1980s. Figure 1 highlights country-wide trends in GDP growth rates in Vietnam. Average growth was 6.5 percent during the last 20 years. Mean GDP growth between 1993 and 1998 was 8.3 percent and 6.3 percent between 1998 and 2002.

Participatory poverty assessments tend to confirm the quantitative evidence (Asian Development Bank *et al*. 2004). These assessments show that hunger has declined and incomes are more diversified and stable. The development achievements have been brought about by increasing agricultural productivity, improvements in infrastructure, and better access to services. Still, poverty is widespread and for many the exit from poverty is fragile and reversible (Asian Development Bank *et al*. 2004).

2.1. Small-area estimates of poverty measures

Researchers at the International Food Policy Research Institute (IFPRI) and the Institute of Development Studies (IDS), in collaboration with the Inter-Ministerial Poverty Mapping Task Force, developed small-area poverty estimates for Vietnam. The small-area estimation method combines two data sets – typically a survey data set with fewer observations but more detailed information for each observation, and a census-style data set with many more observations, but with considerably less information. A variable such as income or (in our case) household expenditure, that is available in the survey but not in the census data, can be estimated for the entire population covered by the

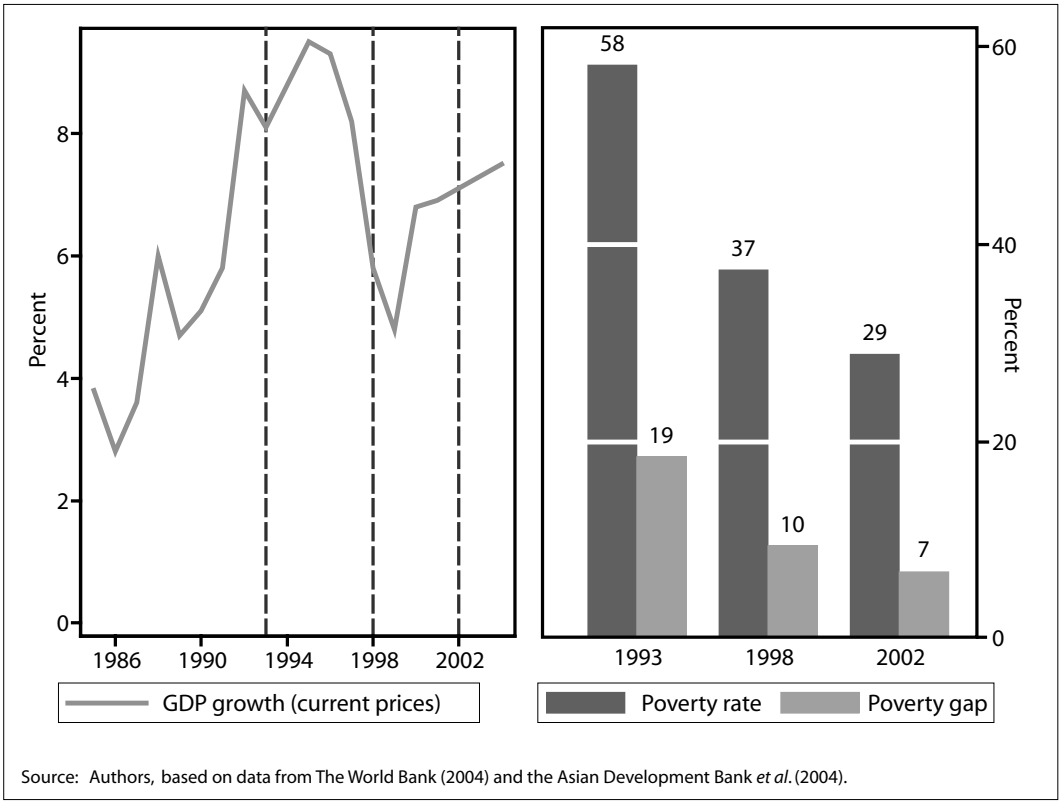


Figure 1. GDP growth per capita and poverty reduction

census in three steps. First, the coefficients between a set of variables and the expenditure variable in the survey data are estimated; second, the estimated coefficients are applied to the same variables in the census data to predict the expenditure for each observation; and, third, the estimated household expenditure is aggregated to administrative units and mapped for the entire area covered by the census and for which the survey is representative. The methodological approach has been applied in a variety of fields for planning and targeting purposes (Ghosh and Rao 1994), and has in recent years also been applied to estimate spatially disaggregated poverty rates in developing countries. The studies developed by Hentschel *et al*. (2000) and Elbers *et al*. (2003) using household-level data, and Minot (2000) using district-level averages, were among the first of that kind.

The estimates for Vietnam were generated from a combination of the 1998 Vietnam Living Standards Survey (VLSS) data and a 33 percent sample of the 1999 Population and Housing Census (PHC). Both the survey and the census were conducted by the GSO of Vietnam with funding from various bi- and multilateral donors. The VLSS is based on a stratified random sample of 6,000 households in Vietnam. In this study we use the commune-level poverty estimates generated by Minot *et al*. (2003). In addition to these commune-level estimates of poverty incidence (P_0), we also estimated the two alternative commonly used measures of poverty at commune level: the poverty gap index (P_1) and poverty severity (P_2). These were determined applying the same methodology and model specification as described in Minot *et al*. (2003). The poverty data used here are the latest country-wide small-area poverty estimates.

The poverty mapping method does not produce exact results. Higher disaggregation of the poverty estimates to smaller administrative units results in higher uncertainty as the standard errors increase. Some of the poverty estimates at commune level can have relatively large margins of error for some communes (Minot *et al*. 2003). Especially, in communes with few households the standard errors are relatively large, and in a quarter the confidence intervals are greater than +/- 10 percent. By using the entire set of poverty estimates we include

over 10,000 observations and the use of the commune-level estimates appears valid for the type of analysis conducted here. The exclusion of communes with large standard errors from the calculations did not alter the qualitative results on which we focus the discussion.

2.2. Spatial distribution of poverty in Vietnam

Policy makers working on poverty reduction tend to focus their attention on socioeconomic indicators that can be influenced by market policies or by investments in rural services. For example, investments in infrastructure and services can improve access to markets and administrative centers, thereby decreasing transportation costs for agricultural inputs and outputs. Specific targeting of such investments towards the poor is one of the central justifications of poverty mapping and spatially disaggregated poverty analysis that allows quantifying and visualizing poverty patterns for small areas (Henninger and Snel 2002). Spatially disaggregated information on the distribution of poverty not only allows decision-makers to better target investments to the rural and urban poor, but also facilitates a more accurate analysis of the factors influencing poverty. Furthermore, the increasing availability of spatial data paves the way for a variety of in-depth analyses into the spatial determinants of, and factors influencing, poverty, as well as into the linkages between poverty and the environment. For an assessment of poverty within a country, spatially disaggregated poverty data are valuable information to facilitate targeting and to reveal spatial patterns and disparities (Hentschel *et al*. 2000; Minot 2000; Henninger and Snel 2002).

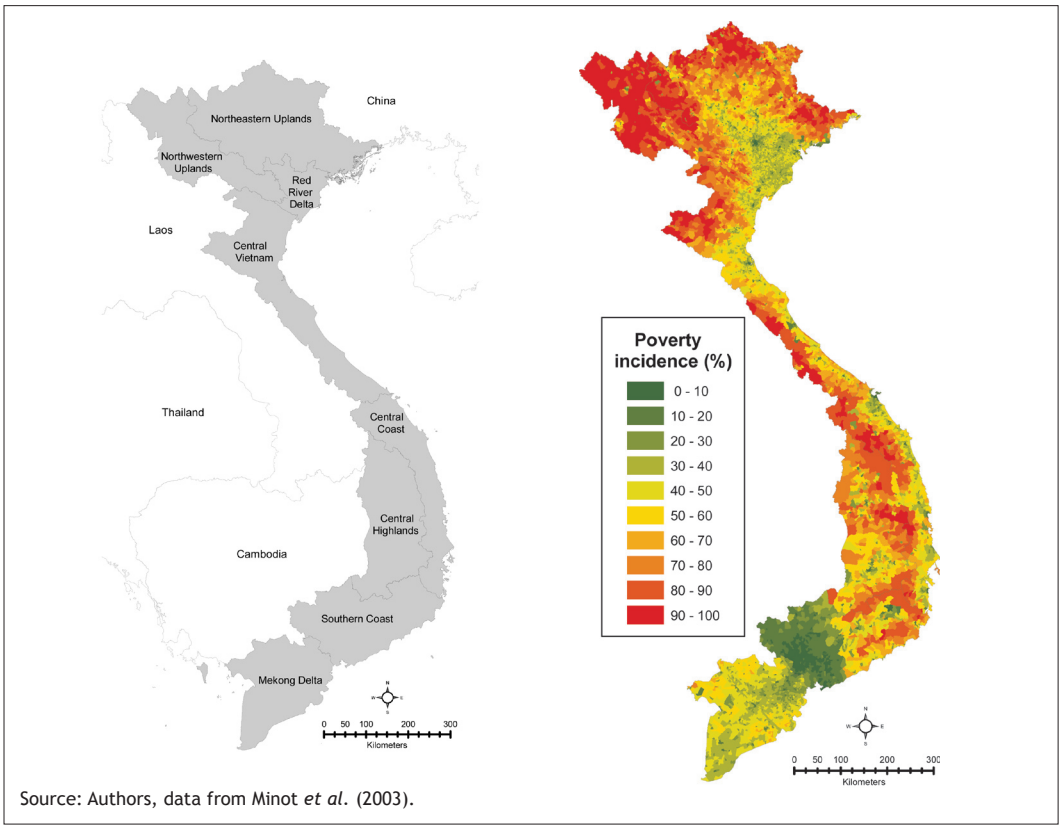
The map on the right side of Figure 2 shows the geographic distribution of poverty in Vietnam. The spatial patterns indicate that poverty incidence is highest in the Northern Uplands, with particularly high poverty rates in the Northwest and the Northeast. Other poverty hot spots are in central Vietnam along the border with Lao PDR and in the Central Highlands along the borders with Lao PDR and Cambodia. The lowest incidences of poverty are found in the Mekong River Delta, in and around Ho Chi Minh City as well as in the Red River Delta close to Hanoi.

2.3. Poverty incidence and poverty density

Both the Mekong River Delta and the Red River Delta are among the most densely populated agricultural areas in the world. The population density map on the left side of Figure 3 shows the two densely populated river deltas as well as the comparably high population densities along the coastline.[2] Poverty density, which is to say the number of poor individuals within a commune, is shown on the right side of Figure 3. The relationship between the two dot density maps is striking. In Vietnam, the highest number of individuals below the national poverty line live in areas that are densely populated. Poverty density tends to be low in areas where poverty incidence (Figure 2) is high.

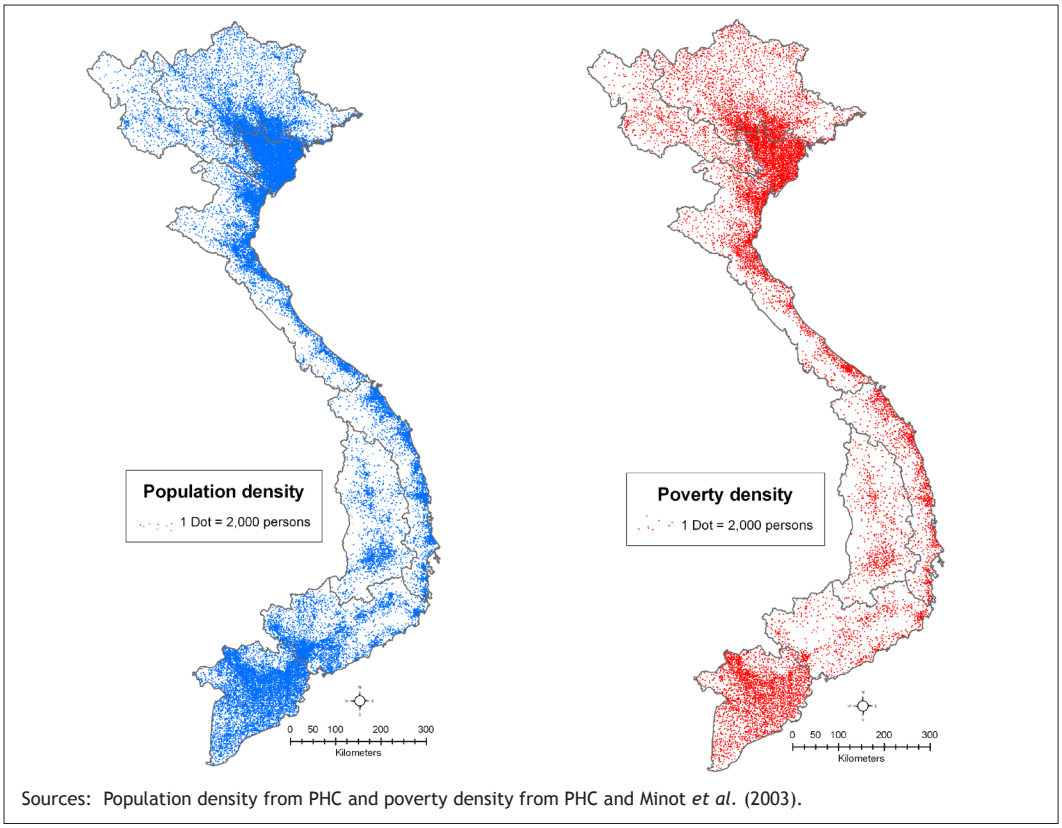
Correlating population density (persons per square kilometer) with poverty density (persons below the national poverty line per square kilometer) reveals the high correlation between the two measures (Figure 4). Population density is a strong determinant of the absolute number of poor individuals in Vietnam. This fact is very important, yet it is often ignored in poverty alleviation programs and policies. The high poverty density in urban areas of Vietnam may be an indication both of the force of rural to urban migration and also of the fact that the country is still relatively early in its path out of poverty. Frequently, urban areas tend to have higher per capita income and often succeed earlier in raising incomes. That is one reason why urban areas are often magnets for migration.

The incidence map in Figure 2 and the density maps in Figure 3 have important implications for the geographical targeting of poverty reduction programs. Decisions based upon the spatial patterns of poverty incidence suggest a bias towards the targeting of areas with high poverty incidence, while the poverty density map on the right side of Figure 3 may imply the targeting of areas with a high absolute number of poor people. Politicians may be inclined to prefer the targeting of the absolute number of the poor, i.e. poverty density, in order to maximize future political support. However, a large share of the poor in the densely populated river deltas has consumption levels closer to the poverty line than in upland regions



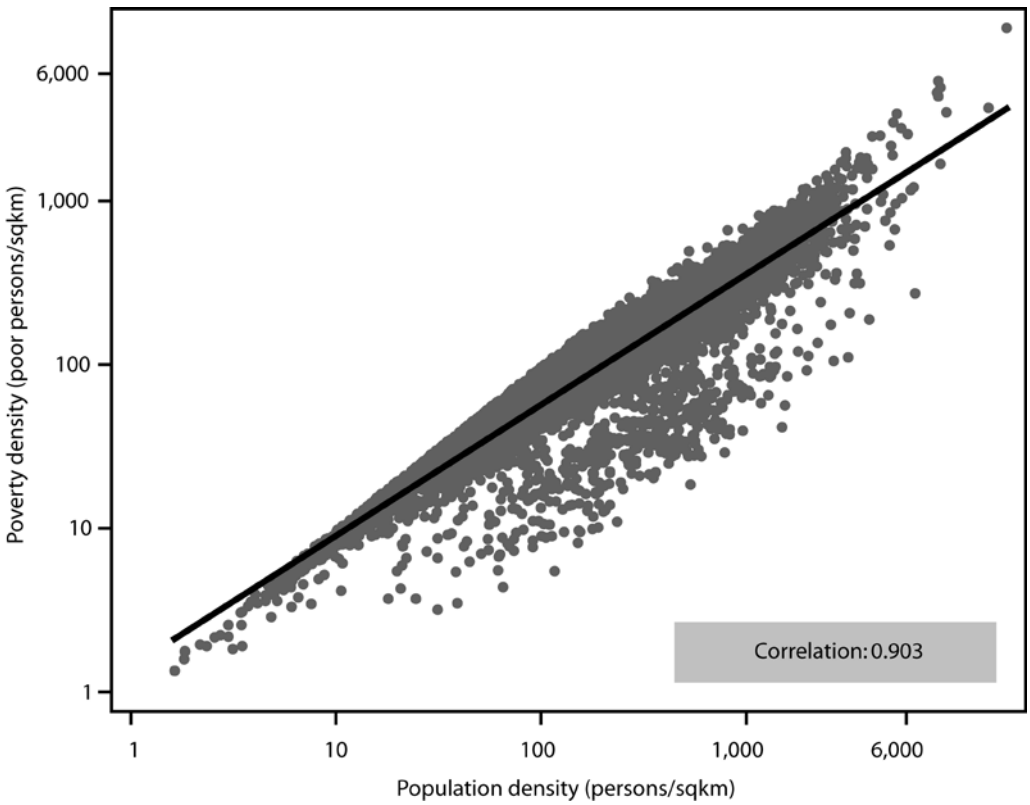
Source: Authors, data from Minot *et al.* (2003).

Figure 2. Regions of Vietnam and poverty incidence (1999)



Sources: Population density from PHC and poverty density from PHC and Minot *et al.* (2003).

Figure 3. Population density and poverty density (1999)



Sources: Population density from PHC and poverty density from PHC and Minot *et al.* (2003); axes on log-scale.

Figure 4. Correlations between poverty density and population density

where the incidence is higher. Poverty in the deltas is therefore more shallow due to a lower poverty gap and small increases in consumption will lift many people above the poverty line (World Bank 2005). Moreover, areas with high poverty density tend to have a larger absolute number and share of non-poor individuals than in remote areas due to the high population density. Such areas require a more resource- and data-intensive identification of poor individuals or households. In remote areas where the incidence of poverty is high, assistance can be directed at the whole population, thereby reaching a large share of poor households. Targeting entire administrative areas in high incidence areas causes errors of inclusion (leakage) through assistance unintentionally reaching non-poor households. However, the benefits of smaller errors of exclusion (undercoverage) of targeting poor population segments are possibly higher than the costs in terms of leakage (Bigman and Fofack 2000; Coady *et al.* 2004).

Ricefield in the suburb of Hanoi (Photo by Ramadhani Achdiawan)

2.4. Other characteristics of poverty

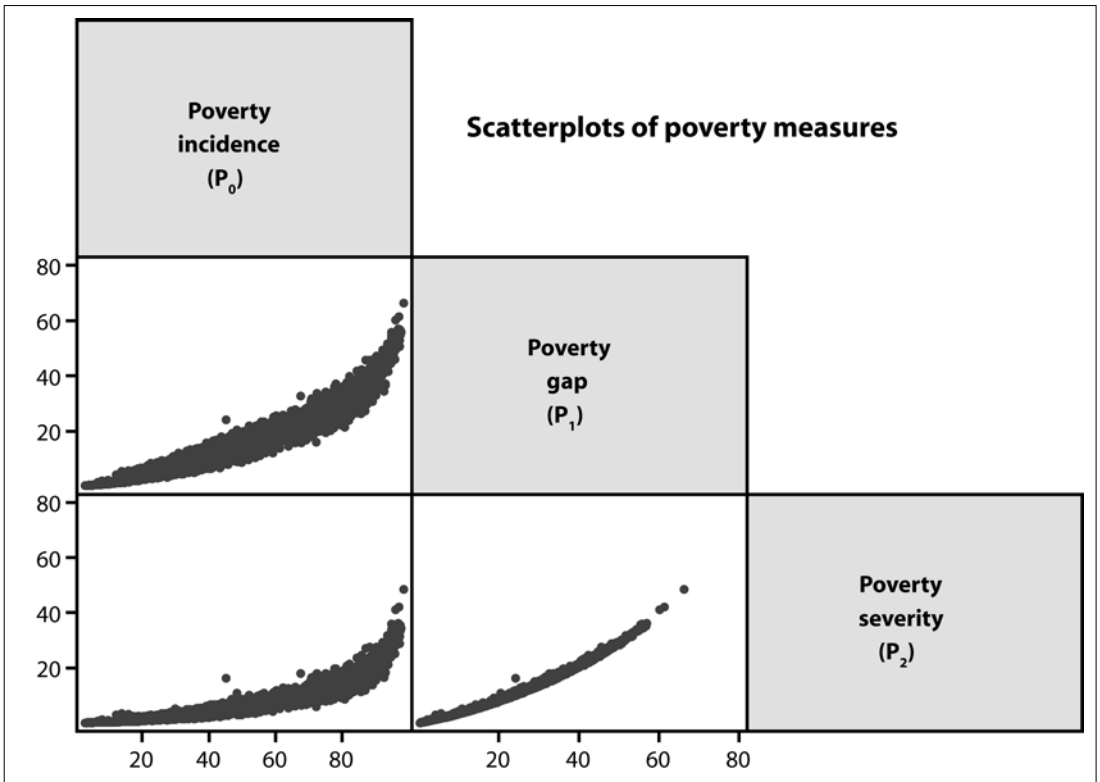
So far we have only looked at the incidence and density of poverty. Other important quantitative measures of poverty characteristics are the poverty gap index (P_1) that provides information on how poor people are, and poverty severity (or the poverty gap squared, P_2) that accounts for the distribution of income (or expenditure) among the poor and gives more weight to larger gaps between an individuals' income and the poverty line (Ravallion 1992). We estimated the poverty gap index (P_1) and poverty severity (P_2) applying the same methodology and model specification as in Minot *et al*. (2003).

Figure 5 shows a close relationship between these three poverty measures in Vietnam. High poverty incidence (P_0) has strong positive linkages with the poverty gap index (P_1) and the severity of poverty (P_2). Both P_1 and P_2 are high in areas where P_0 is high, such as in the Northern Uplands and the Central Highlands.[3] Therefore, poverty is more severe and people are further below the poverty line in areas where poverty incidence is high (Minot *et al*. 2003).

2.5. Clusters of poverty incidence

We observe geographic pockets of high and low incidence of poverty (Figure 2). Obviously, poverty rates are spatially related and exhibit potential spatial autocorrelation, i.e. a coincidence of value similarity with locational similarity (Anselin 1988). Commune-level poverty rates tend to be similar in communes that are located close together.

We examine the degree of spatial correlation with the Moran's I statistic.[4] Moran's I ranges from -1 for negative to +1 for positive spatial autocorrelation, meaning that the value of a particular variable at one location is functionally related to that same variable at other locations (Anselin 1988). A Moran's I of zero implies an absence of spatial patterns. Moran's I can be calculated

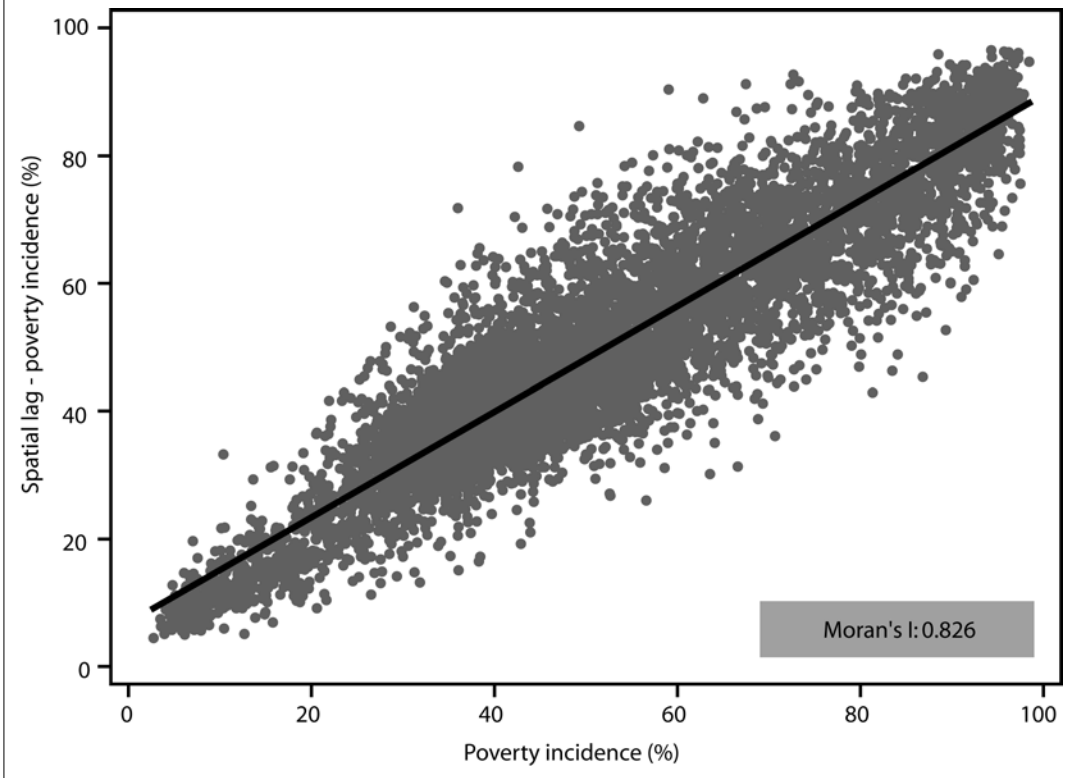


Sources: Poverty incidence from Minot *et al*. (2003) and own calculations for commune-level poverty gap and poverty severity based on expenditure estimates from Minot *et al*. (2003).

Figure 5. Relationships between poverty measures

with a spatial lag model where the spatial lag variable contains the information from neighboring locations of the variable of interest (poverty incidence). A spatial weight matrix defines the contiguity structure of the assumed spatial relationships between the observations. The specification of the spatial weight matrix is based on the researcher's best guess regarding the functional relationships and, therefore, involves an arbitrary component. We tested several specifications of the spatial weight matrix, all of which showed similar policy implications. In the following, we report the results using a second-order cumulative queen contiguity matrix for the visual inspections of the spatial clustering of the poverty estimates.[5]

The poverty data for Vietnam indeed show clear evidence of spatial autocorrelation, as can be seen in the spatial lag models for poverty incidence in Figure 6. The poverty incidence has a strong positive relationship to its neighboring values with a Moran's I of 0.826. This implies that a high (or low) poverty incidence in one commune makes it more likely to be seen in the surrounding communes as well. Poverty is spatially clustered, with geographical pockets of high incidence, especially in the Central Highlands and in the Northern Uplands, and clusters of low incidence in the river deltas and along the coast (see also Figure 2).



Sources: Own calculation and poverty estimates from Minot *et al.* (2003)

Figure 6. Moran's I for poverty incidence

3. Forest cover

The forest data used in this study, representing the forest cover situation of 1999, were produced by the Vietnamese government's Forest Inventory Program 286.[6] The forest cover data are classified into six classes, of which four exhibit actual forest cover. The first three are natural forest categories (rich, medium, and poor) and the fourth is plantation forest. The fifth category is agricultural land and the sixth includes all other land cover representations including shrub, bare and grass land, water bodies and built-up areas. Other country-wide forest cover data of comparable quality and spatial resolution are not available for Vietnam. This inhibits a more in-depth investigation, for instance, of changes in forest cover over time. The forest cover data we use here are the official data used by the government for the monitoring of the VDGs.

The official forest cover data that we employ are not always above all doubts and are hence a matter of controversy (Sunderlin and Huynh 2005). According to an internal government report, the accuracy of forest data ranges from 65 - 95 percent, depending on factors like the method of data collection and compilation, the complexity of topography, and the homogeneity of forests. In addition to the reported data inaccuracies, we suspect that forest cover statistics may partly reflect underlying political motivations at different administrative levels. Nevertheless, it is the only available official spatial data set of forest cover to date.[7] Decision No. 32 of the Ministry of Agriculture and Rural Development (MARD) states that the results of Program 286 are the basic scientific data source for forest and rural development planning. We employ this data set to take monitoring activities and

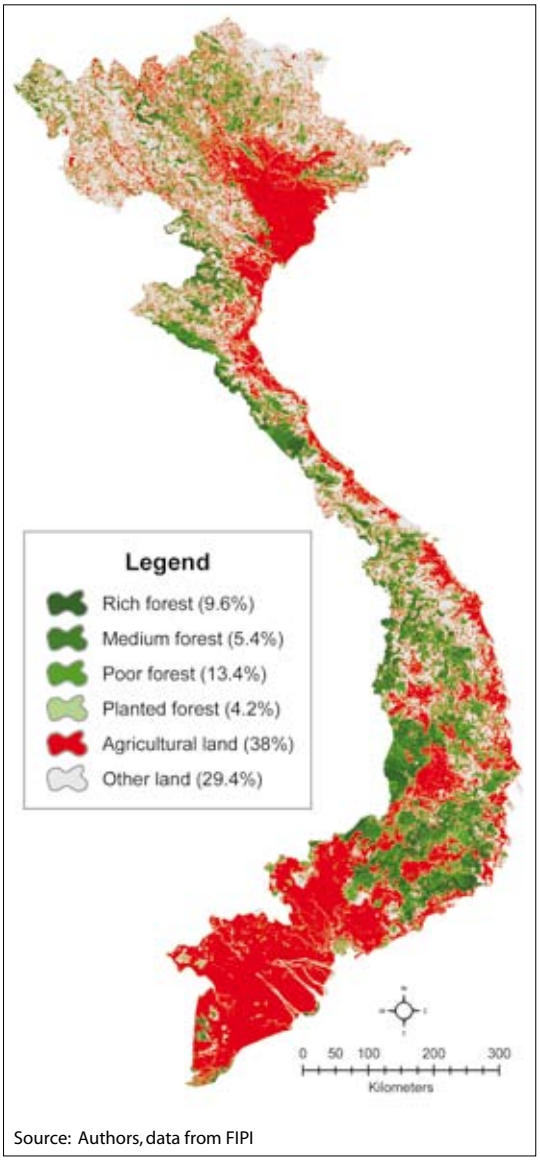
Dense forest cover
in Kon Tum province
(Photo by Tran Huu Nghi)

analysis of poverty-environment relations in Vietnam a step further. Also, our aggregation of the forest cover data to the commune level avoids large locational inaccuracies of the raster data.

The forest quality map (Figure 7) shows that overall forest cover is 32.6 percent of the total land area. This consists of rich (9.6 percent), medium (5.4 percent), poor forests (13.4 percent), and plantation forest (4.2 percent). Agricultural areas cover 38 percent of the total land area and other land covers 29.4 percent. Most rich and medium forests in Figure 7 are concentrated along Vietnam's borders with Lao PDR, in the Central Highlands and in Central Vietnam. Forests with lower densities are found in the Northwestern and Northeastern Uplands.

All data are stored in a Geographic Information System (GIS), referenced to the same coordinate system. Commune-level statistics of forest cover were obtained by aggregating the raster data. Through this process of aggregation, the total area and percent of forest cover for all forest cover categories within each of the 10,476 communes existing in 1999 were derived. We excluded all islands owned or claimed by Vietnam from the calculations due to missing data and to reduce complexity in the interpretations of the maps.

The limited existence of disaggregated data of other environmental measures meant that a more comprehensive analysis of a poverty-environment nexus, including additional environmental indicators, was not possible at this stage. Some authors argue that poverty may be a critical constraint for the conservation of biodiversity. Policies that fail to account for the complex relationships between the two run the risk of failure. It is therefore being argued that poverty reduction and biodiversity conservation have to be jointly tackled (Adams *et al*. 2004). The conservation of biodiversity is an aim agreed upon in the MDGs, but disaggregated country-wide indicators are not available for Vietnam. We therefore are not able to give attention to the interactions of poverty and biodiversity in this paper.



Source: Authors, data from FIPI

Figure 7. Forest cover (1999)

4. The poverty-forest nexus

4.1. Empirical evidence

We confine our analysis to the static relations of poverty measures and forest cover, both measured in 1999, as consistent forest cover data over time as well as spatially disaggregated time series of poverty incidence are not available. While this prevents us from contributing to the deforestation-poverty debate (e.g., see Gutman 2001; Geist and Lambin 2003; Shively 2004), we explore a unique combination of data to take an in-depth look at the spatial relationships between poverty and forest quality in Vietnam at one point in time.

Areas with high poverty incidence are likely to have more forest in Vietnam (Minot *et al*. 2003; Asian Development Bank *et al*. 2004; Sunderlin and Huynh 2005). Closely linked to this pattern, more forest cover is more likely to be found in areas with high shares of people from ethnic minority groups, whose livelihood strategies traditionally depend on forest resources and on swidden cultivation. Moreover, ethnic minorities tend to live in less accessible areas, with more topographic variation, and further away from markets. And ethnic minority households made much slower progress in poverty reduction than the ethnic Vietnamese (World Bank 2005).

Few studies investigate the links between environmental indicators and poverty in a spatially explicit way. Dasgupta *et al*. (2005) investigate the spatial linkages between poverty and five environmental indicators, including deforestation, in Lao PDR, Cambodia, and Vietnam. They find no evidence of a deforestation-poverty nexus for Vietnam, but conclude that sub-district-level analysis may reveal such links.

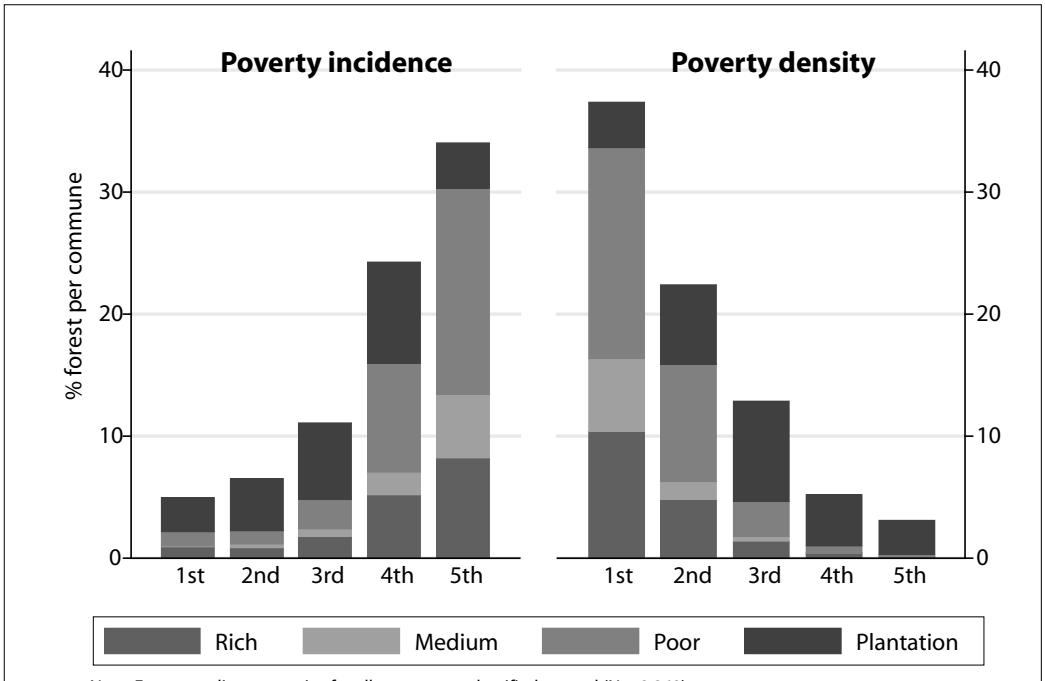
We adopt a spatially-explicit research approach linking forest quality, as an environmental indicator, to poverty incidence at the commune level. Specifically, we look at spatial correlations and regional linkages

Firewood collection by ethnic E De women in Dak Lak province (Photo by Tran Huu Nghi)

between the forest cover data set and small-area poverty estimates to improve understanding of the relationship between poverty and forest quality in Vietnam. The data set we use is unique because of its national coverage and because of its high spatial resolution, including population data from the 1999 Population and Housing Census.

In the tropics, extensive forest areas often geographically coincide with areas exhibiting high poverty incidence and are concentrated in remote areas with poor accessibility (Wunder 2001). Vietnam clearly falls into this category (graphs on the left side of Figure 8 and Figure 9). The higher the poverty incidence in a commune, the higher is the likelihood of high forest cover percentage.[8] The communes in the poorest quintile have a mean forest cover of 33 percent, almost 9 percent of that being rich forest. Communes with the lowest incidence of poverty have a mean forest cover of around 6 percent, most of that being plantation forest (left graph of Figure 8). A different picture emerges from the graph on the right side of Figure 8 that depicts the forest cover percentage per commune by quintiles of poverty density. Communes in the highest quintile of individuals below the poverty line, i.e. with the highest poverty density, tend to have virtually no forest left, while 37 percent of the communes in the sparsely populated upland areas of the lowest poverty density quintile tend to have a high share of forest cover.

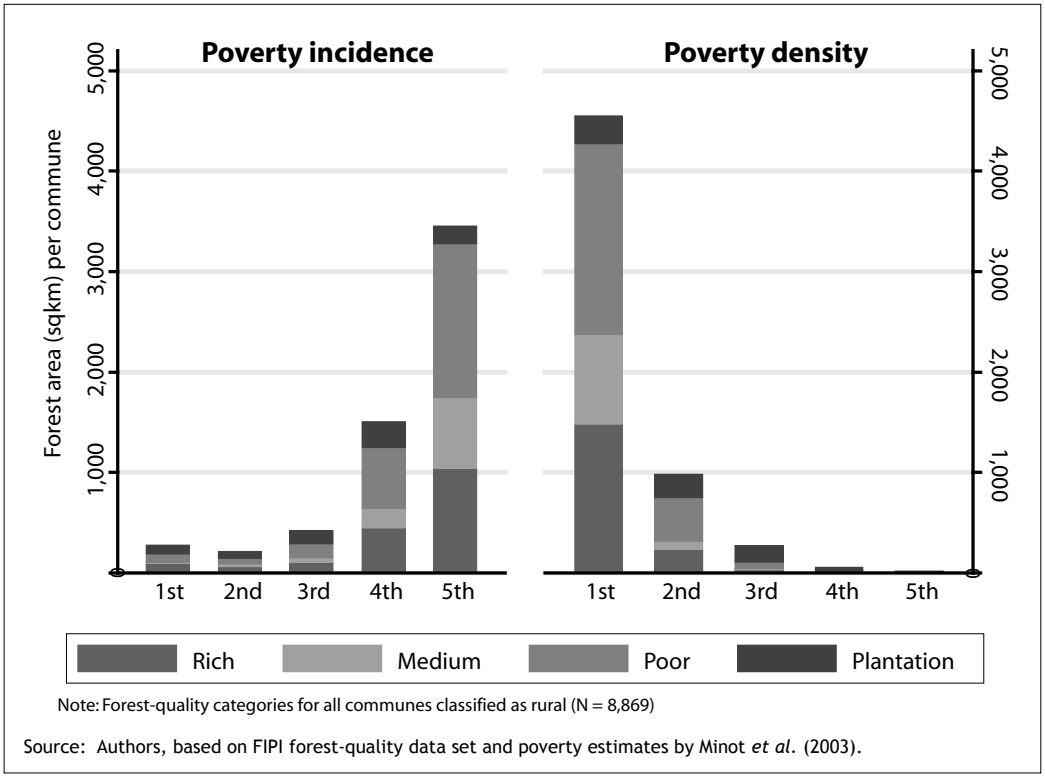
To account for the fact that in remote, sparsely populated areas, communes typically are larger than in densely populated areas, we also compared communal forest areas in terms of quintiles of poverty density. The variations of forest area are consistently more pronounced when looking at size of forest area per commune (Figure 9). The first quintile, with the lowest poverty density, comprises three quarters of all the forest area that existed in Vietnam in 1999 (right graph in Figure 9). Consequently, the number of individuals below the poverty line and the incidence of poverty are strongly related to the amount of forest cover in Vietnam. More forest cover is observed where fewer poor people live, and conversely, where poverty incidence is higher, and where both the poverty gap and the poverty severity are more pronounced.



Note: Forest-quality categories for all communes classified as rural (N = 8,869)

Source: Authors, based on FIPI forest-quality data set and poverty estimates by Minot *et al.* (2003)

Figure 8. Percentages of forest categories by quintiles of poverty measures



Note: Forest-quality categories for all communes classified as rural (N = 8,869)

Source: Authors, based on FIPI forest-quality data set and poverty estimates by Minot *et al*. (2003).

Figure 9. Area of forest categories by quintiles of poverty measures

4.2. Spatial relationships in the poverty-forest nexus

Geographic mapping of tabular data can reveal spatial patterns of a single variable, as well as spatial relationships among multiple variables. Bivariate local indicators of spatial association (LISA) illustrate location-specific clusters and heterogeneity between two variables (Anselin 1995; 2005). LISA maps indicate the linear association between two variables at neighboring locations. High-High (HH) and Low-Low (LL) locations are referred to as spatial clusters of high and low values, respectively. High-Low (HL) and Low-High (LH) locations denote negative local spatial autocorrelation and are termed spatial outliers.

We use bivariate LISA to assess and reveal spatial patterns between commune-level poverty incidence and the percentage of rich forest (map on theleft side of Figure 10) as well as the percentage of all natural forest categories, i.e. rich, medium, and poor forest (map on the right side of Figure 10), at commune level. We use cumulative second-order queen contiguity weights as described in section 2.5. HH and LL locations in Figure 10 indicate that neighboring communes tend to have similar high or low values of forest and poverty rates, corresponding to positive local spatial autocorrelation. In HL and LH areas, neighboring values of poverty incidence and forest cover indicate a dissimilarity resulting in a checkerboard pattern (Anselin 2005). HL stands for high poverty incidence and low forest cover and, conversely, LH indicates a commune with low poverty incidence that is surrounded by communes with high forest cover percentage. White areas have low pseudo-significance levels with p-values above 0.05. To create the maps we use a randomization of 9,999 permutations to avoid large sensitivities in the results.[9]

Both maps in Figure 10 reveal LL clusters in both river deltas and partly along the coastline, where low poverty incidence tends to accompany low forest cover percentages in surrounding locations. In the Northern Uplands, Central Vietnam and in the Central Highlands, HH clustering is evident as high poverty incidences coincide spatially with large areas covered by forests. The patterns

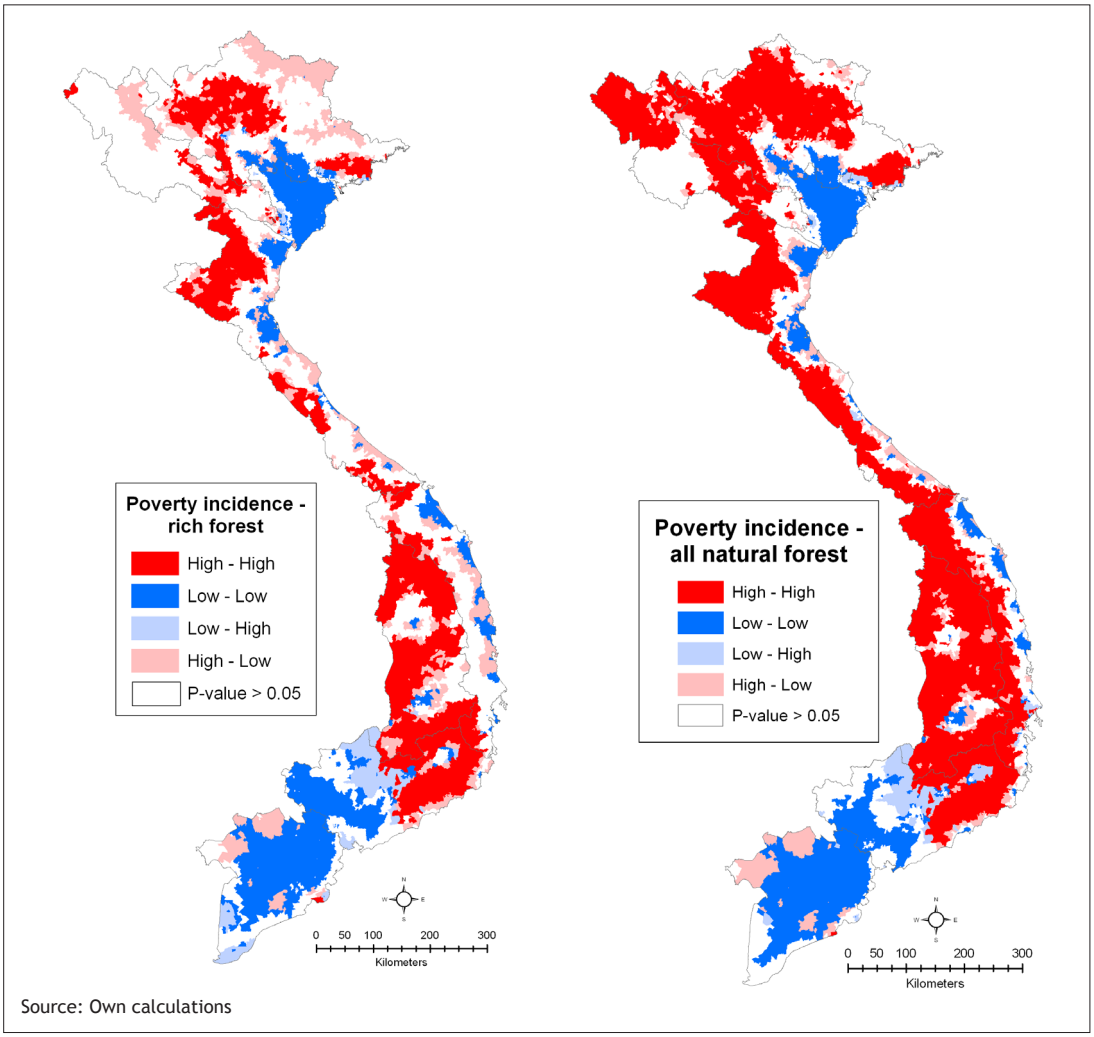


Figure 10. LISA cluster maps of poverty incidence and forest categories

are generally more pronounced in the map on the right side of Figure 10 which includes all natural forest categories.[10]

If the objective of a policy or program is the alleviation of poverty in high-incidence areas, coupled with a concurrent conservation of rich forest, the maps in Figure 10 can generate important insights for geographic targeting. The map on the left side of Figure 10 reveals that such investments might yield considerable benefits in the HH areas in large parts of the Central Highlands, the northern part of Central Vietnam along the border with Lao PDR, and in the western part of the Northeastern Uplands. Interventions aimed at protecting and improving existing forest-based livelihoods, and especially those that tend to protect forest cover and biodiversity in the long term, could be highly productive both for livelihoods and also for environmental goals. Moreover, policies or programs aimed at reducing high incidence (and gap and severity) of poverty in areas of low forest cover might aim for reforestation in the HL zones, provided that such activities are consistent with existing livelihood modes and with the suitability of available land, among other considerations.

However, such interventions need to pay careful attention to the dynamics generated by rising incomes. Historical evidence suggests that increasing income levels often coincide with decreasing forest cover (Sunderlin *et al*. 2005). As explained in the emerging scientific literature on the "forest transition," there is a tendency for forest cover to decline in the early stages of economic development (Rudel 1998; Mather and Fairbairn 2000; Rudel *et al*. 2005). Although there are no conclusive data linking

increased income to deforestation at the level of the site in Vietnam, it is reasonable to suppose that this has occurred in Vietnam as it has in other developing countries (Sunderlin and Huynh 2005). Arguably, in some rural areas of Vietnam, future increases in living standards will be achieved through the conversion of forests to agriculture and other uses, as they have been in the past. On the other hand, there are clearly areas in Vietnam where livelihoods are, and will continue to be, supported by forest resources (Sunderlin and Huynh, forthcoming).

The experience of Dak Lak province in the Central Highlands in recent years is an important case illustrating what we explain above. On the one hand, rapid deforestation and rising incomes appear to have happened together. The two LL segments indicate two provincial capitals and their immediate vicinity. The adjacent HL areas in the map on the left side of Figure 10 show the comparatively wealthy area in Dak Lak where most of Vietnamese coffee is produced. This production of coffee resulted in rising incomes and large-scale removal of forest cover during the 1990s. On the other hand, over-production of coffee in Vietnam and worldwide in recent years led to precipitous declines in the price of coffee and in the incomes of coffee farmers (Sunderlin and Huynh 2005). There are many such boom and bust cycles in cases where agricultural export commodities have replaced forest cover. Policy makers would do well to carefully consider the implications of investments in specific commodities in advance.

How will policy makers be able to distinguish those areas where poverty reduction is consistent with keeping forests standing from those that will benefit from at least partial forest conversion? The decision will often be dependent on regional specificities, resource endowments, local objectives and livelihood strategies, not typically contained in census or national survey data. For that reason, it is important for national policymakers to improve research capacity for addressing these vital questions.

Firewood collection by ethnic Vietnamese women in Thua Thien Hue province (Photo by Tran Huu Nghi)

5. Conclusions

The focus of this paper is the link between poverty and forest cover, motivated by the long-term policy objectives of the Vietnamese Development Goals. We assessed and compared the spatial distribution of forest and poverty in Vietnam using currently available official data sources. Poverty measures are matched to forest cover data in order to investigate the forest-poverty nexus at the commune level. Our approach is an attempt to contribute to better targeting of rural development investments that adequately integrate poverty reduction and environmental protection investments in rural areas. We also want to highlight the important implications of geographic variations of poverty density, poverty incidence, and forest quality for the targeting of investments aimed at poverty reduction and environmental sustainability.

The spatial framework facilitates an in-depth investigation of geographical linkages between forest cover data and our measure of economic poverty, based on expenditure data. Exploratory spatial data analysis revealed the distribution of the absolute number and proportion of people below the poverty line in Vietnam. High poverty density is most widespread where the majority of the people live, i.e. in the Mekong River Delta and the Red River Delta. Poverty incidence is highest in upland areas, namely the Northeast and Northwest, the Central Highlands, and along the border with Lao PDR in Central Vietnam.

If the objective of a poverty reduction program is solely to reduce the number of poor, a relevant indicator for poverty targeting could be the density of poverty. The maximum reduction in the number of poor individuals in Vietnam could be achieved by targeting poverty alleviation programs in the most densely populated areas. Whether poverty reduction measures target poor areas with low poverty densities but high poverty incidences, or whether the priority is to reach the largest number of poor people is an important question and implies widely varying approaches. Other disaggregated measures of poverty, particular the poverty gap and poverty severity, and inequality indices are therefore of crucial relevance for development policies. Areas with a high poverty density have a much larger share of non-poor people due to the high population densities. That implies high targeting costs to reach individuals or households, while in areas with a high share of poor households the assistance can be spread over the whole area, thereby including few non-poor recipients.

The areas with high poverty incidence tend to be in more remote locations and households there tend to be further below the poverty line. Progress in poverty reduction in remote areas of Vietnam is significantly more challenging than poverty reduction in non-remote areas. Remote area poverty reduction is now one of the key challenges for sustained future poverty reduction.[11] The Government of Vietnam has increased its attention to poverty reduction in remote areas in recent years (World Bank 2002; 2005). Moreover, improving livelihoods in remote areas of Vietnam requires policy changes that allow poor people to get better returns on their key resource: forest land (Swinkels and Turk 2004).

Environmental objectives are of growing importance in the targeting of development investments. These include aspects like forest cover and forest quality. Forest resources are currently important for many of the rural poor, and have the potential to create new income opportunities, in addition to being the habitat for much of

Vietnam's fauna and flora and serving as a carbon sink. The Millennium Development Goals to integrate ecological aspects of sustainable development into policies and programs in order to halt, or possibly reverse the degradation of environmental resources are also reflected in the objectives of the VDGs. Nevertheless, forest conservation and poverty reduction may not always go hand in hand. Forest-consuming activities like conversion to agricultural land are often the only option for rural dwellers to increase living standards. This complexity underscores the importance of funding research which carefully distinguishes between areas where forest conservation and restoration do or do not support the wellbeing of local populations.

We jointly assessed the state of two indicators of the VDGs, namely poverty incidence and forest cover. The relationships between the two are not surprising, but the quantitative evidence is nevertheless striking. The largest part of the natural forest is located in areas where, in absolute numbers, few poor people live, but where poverty is widespread and severe and where inequality is often higher than the national average. Measures to alleviate severe poverty frequently coincide geographically with natural resources that are of high regional and global value such as natural and pristine forest land. Local valuation of natural resources, not reflecting regional or global externalities, may differ significantly and conversion may be a more attractive option to improve living standards than conservation.

Better data on forest cover and the state of biodiversity is a prerequisite to enable consistent monitoring of progress towards the socioeconomic and environmental development goals, stated and signed by the international community and the Vietnamese government. Time series data on forest cover and poverty measures will enable geographical monitoring and insights that will improve the targeting of environmental and economic policies and programs. Several living-standard measurement surveys have been conducted to date in Vietnam, but no consistent data sets on forest cover exist. That is surprising and regrettable, as the forest sector is of crucial importance for both the socioeconomic and also the environmental goals of the Vietnamese government.

It will be just as important to produce socioeconomic data on levels of dependence on forest resources in remote, high forest cover areas, and on future preferences of what to do with forest cover. In some areas, preferences to keep forests standing will be high, not just because of high current dependence, but also because the reasons for converting forests are absent. For example, the soil fertility underlying such forests might be low, or there might be weak markets for agricultural products in remote areas. Conversely, there will be some areas where the two major paths out of poverty will be either leaving the forest (migrating to urban areas) or converting the forests to support a growing population and/or to increase household income.

We conclude by emphasizing that, while mapping of poverty and forests might be a useful tool for identifying ways to optimize poverty reduction and forest conservation or restoration, it is a preliminary step and it cannot stand on its own. Such mapping exercises must be complemented by socioeconomic and biophysical research to produce robust and detailed plans for overcoming poverty and forest cover loss.

Endnotes

[1] On April 1st, 1999, one US$ was equal to VND 13,904 (www.economist.com/markets/currency/fullconverter.cfm). Therefore, the GSO poverty line in 1999 is equivalent to an annual income of US$ 129 per person.

[2] The dot density maps of Figure 3 randomly distribute each dot, representing 2,000 individuals, within the commune boundaries to avoid the misleading effect of graduated color maps where large areal units dominate the interpretation over smaller areas.

[3] We examine poverty measures only and disregard inequality. Inequality is high in some upland areas and tends to be lower in the river deltas and along the coast (Minot *et al*. 2003). We also do not consider chronic poverty (lasting five years or more), which is also likely to have a significant positive relation with high poverty incidence, poverty gap, and poverty severity.

[4] Moran's I is a common measure to quantify the degree of spatial autocorrelation. It is a two-dimensional measure, similar to the Durbin-Watson test for univariate time series correlation (Anselin 1988).

[5] The queen contiguity matrix considers all surrounding neighbors that have a common edge with the observation of interest, in analogy to the game of chess (Anselin 1988). Our second-order matrix is cumulative, as it accounts for all observations that are contiguous to the observation of interest as well as to second-order neighbors.

[6] This forest cover data set was approved by the Prime Minister on January 1, 2001.

[7] Improved forest cover monitoring is part of the policy objective of strengthening the sustainability of natural resource use in rural areas between 2003 and 2005, stated in the Comprehensive Poverty Reduction and Growth Strategy of the Vietnamese government (Socialist Republic of Vietnam 2002).

[8] We exclude urban areas from the comparisons. The inclusion of urban areas, where a small percentage of people are poor, but a lot of poor people live, would enlarge the differences in Figure 8 and Figure 9 even more as forest cover in urban areas is negligible.

[9] All LISA indicators are calculated using GeoDa™ (Anselin 2005). The randomization approach assumes the location of the values and their spatial arrangement to be irrelevant. Based on the assumption of randomization different theoretical standard deviations for the Moran's I are obtained, each yielding a different p-value as a pseudo-significance. The p-values follow an asymptotically standard-normal distribution that allows judging their significance level by comparing them to a reference distribution (Anselin 1992).

[10] The inclusion of plantation forest does not change the qualitative insights from these results.

[11] Personal communication with Carrie Turk, Senior Poverty Specialist, World Bank Vietnam, January 4, 2006.

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This Working Paper analyses a remarkable fact. In Vietnam, the areas with the lowest poverty density (total numbers of poor people per unit of area) and with the highest poverty rate (proportion of people in poverty) tend to be in remote places where the largest areas of forest cover remain. Conversely, the areas of high poverty density and low poverty rate tend to be in non-remote places with low forest cover. This paper visualizes the forest-poverty nexus using geographic data and analyzes the implications of these spatial patterns for poverty reduction and for improved forest management and conservation.

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