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Evaluating the Local Socio-economic Impacts of Protected Areas: A System Level Comparison Group Approach

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1. Executive Summary

1.1 Overview

This report develops and applies a new comparison-group based method for evaluating the socio-economic effects of protected areas on local communities across a protected area system.[1] The project was designed to extend and complement program evaluation methods previously developed by the GEF Evaluation Office.

Protected areas, including those supported by the GEF, now cover a significant fraction of global land area. However, little is known about their net effects on local incomes or poverty rates. Community-level economic development could be reduced by restrictions on land use or resource extraction activities but could also be supplemented by a new tourism sector or increased environmental benefits. Empirical work on the actual impacts of protected areas has been limited to date by: 1) the lack of data on poverty outcomes at the appropriate spatial scale and 2) the non-random selection of protected area locations, which complicates the construction of a useful comparison group.

The approach presented here analyzes a protected area system across a national or sub-national area with respect to socio-economic and environmental impacts at the community level. This method is applied in the context of Thailand's national protected area system, using data at the sub-district level from the North and Northeast regions of Thailand. To measure socio-economic outcomes, the method uses data from new poverty mapping techniques that estimate community-level incomes and poverty rates. To assess impacts, the approach relies on evaluating differences between communities with protected land and comparison communities in the same province or district, with similar likelihood of protection and similar pre-protection development potential. The comparison group was constructed on the basis of an analysis of the history of protected area designation in Thailand, in order to account for the key factors that determined protection and might also influence outcomes.

The method presented here can be of more general use beyond Thailand. It could productively be used to evaluate protected areas in other countries or to evaluate impacts of other large scale environmental projects supported by the GEF. Ideally, this methodology can complement existing studies, including case comparisons or household survey work, by providing a broader overview of impacts across a larger number of sites.

1.2 Summary of findings: Thai protected areas

The results of this study indicate that protected forest areas in North and Northeast Thailand have prevented forest clearing that otherwise would have occurred and thus have imposed a constraint on land available for agricultural use. Sub-districts with more land in protected areas had significantly more forest cover by the year 2000 than appropriate comparison

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[1] This report draws sections of material from a working paper by the author; see Sims (2008).

sub-districts (9-25 percentage points for national parks, 11-32 percentage points for wildlife sanctuaries).

Despite reducing land available for agricultural production, this study finds that national parks and wildlife sanctuaries did not harm average consumption levels[2] or increase poverty rates. Looking only at correlations, sub-districts with more land in protected areas were indeed substantially poorer than the province averages. After controlling for geographic characteristics and pre-protection development potential, however, the analysis indicates that this poverty is not the result of the protected areas. Sub-districts with more land in wildlife sanctuaries did not have significantly different consumption levels or poverty headcounts than appropriate comparison sub-districts. Sub-districts with more land in national parks had significantly higher consumption levels (2-7 percent) and lower poverty rates (4-12 percent) than comparison sub-districts. However, inequality measures are higher on average for communities near the national parks, indicating that a disproportionate share of these gains went to higher income households.

The results suggest that, on average, at the community level, the gains from protection have been high enough to offset the costs of land use constraints. The most probable mechanism for the positive economic effect of national parks is increased income from tourist visits in and near the parks. The Thai government has actively promoted national parks as tourist destinations and official statistics indicate over 10 million tourist visits to national parks in 2000. Consumption levels are positively associated with popularity of parks as measured by tourist visits; a higher flow of tourists is a likely explanation for the stronger positive effects for national parks compared with wildlife sanctuaries, where tourism opportunities are limited.

2. INTRODUCTION

2.1 The GEF and protected areas

The GEF has supported the establishment of protected areas throughout the world and is currently supporting protected area network initiatives in Thailand (UNDP Thailand 2008). Worldwide, conservation areas have expanded by more than 10 times in the past three decades.[3] This expansion has lead to intense debate about whether and under what conditions forest conservation or protected areas will harm or help the economic progress of local communities, particularly in developing countries (e.g. Coad et al. 2008, Agrawal and Redford 2006, Chomitz 2006, Dowie 2005, Naughton-Treves et al. 2005, Sunderlin et al. 2005, Adams et al. 2004, Sanderson and Redford 2003, Brandon et al. 1998).

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[2] This includes household consumption of food, apparel, housing, medical care, transportation, education, etc. It includes purchases by the household as well as consumption of items produced directly by the household.

[3] IUCN (World Conservation Union) and WCMC (World Conservation Monitoring Centre) numbers cited by Zimmerer, Galt and Buck (2004).

A key objective of the current GEF Biodiversity Strategy is to "catalyze sustainability of protected area systems."[4] This includes building capacity for benefit sharing by local communities around protected areas as well as generally strengthening marine and terrestrial protected area systems. These goals may be assisted in part by an increased understanding of how protected area systems contribute to local livelihoods. Additional tools and knowledge about impacts can potentially improve the targeting of investments in protected areas by GEF and others.

2.2 Developing a system-level comparison group approach

A variety of methods exist to evaluate impacts of conservation programs. Choices about the spatial and temporal scale of the study, the metrics used to measure poverty or economic well-being and the method of evaluation used to determine impacts will determine the types of conclusions that can be drawn from each study.

The methodology used in this project can be summarized as follows. (More detail on the sources of data and methods is given in Section 3 below).

- Study scale: the study assesses medium-term impacts on communities across a protected area system.
- Development metrics: poverty and economic well-being are measured by material consumption/assets, taking advantage of new small-area estimation techniques or "poverty mapping" results.
- Assessing impacts: impacts are evaluated using a quasi-experimental or comparison-group based approach. Socio-economic outcomes for localities that were included in protected areas were compared to the outcomes for other localities with similar initial characteristics and similar probability of protection.

These choices of study design were made in order to develop a methodology that could fill gaps in the existing literature on the local impacts of protected areas. Most previous retrospective studies of local economic development impacts have not included a comparison group and have not been able to assess impacts across a protected area system. Case studies of protected area impacts can provide rich detail on a small number of households, projects, or communities and have advantages in terms of forming hypotheses about mechanisms or details of contextual background. System-level studies collect less detailed information for a larger sample, but offer the potential for greater statistical power and ability to generalize. In Appendix A, I offer a brief review of previous literature on the local impacts of protected areas, with a focus on drawing out the gaps in the literature that motivated this study.[5]

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[4] Biodiversity Focal Area Strategy and Strategic Programming for GEF-4. Accessed 8/27/08 at: http://www.thegef.org/uploadedFiles/Focal_Areas/Biodiversity/GEF-4%20strategy%20BD%20Oct%202007.pdf

[5] For a recent full review of literature on local costs and benefits, see Coad et al. 2008.

3. METHODS

3.1 Data sources

A spatial database was constructed to combine data from several different sources. GIS software was used to overlay layers and calculate variables needed for the analysis. The sources of data and variable definitions are listed in Table 1 and are discussed briefly below.

3.1.1 Administrative units

The methodology developed for this project evaluates impacts for local communities across a protected area system. The system studied here consists of protected forest areas covering the North and Northeast of Thailand. Thailand has 76 provinces, which are divided into districts ("amphoes") and sub-districts ("tambons"), which in turn consist of several villages. This analysis focuses on the North and Northeast regions, which is where the majority of remaining forests are located.[6] The areas are landlocked, so there are no marine protected areas in the sample. The sample considered in this study includes 36 provinces, which include more than 4000 sub-districts. The average size of a sub-district in these regions is 82 sq km and the average population is around 5000 people.

3.1.2 Socio-economic outcomes

A major hurdle to assessing protected area impacts has been the lack of data on local-level economic development. This research takes advantage of new "poverty-mapping" or "small area estimation" measures. These methods, developed by Elbers, Lanjouw, and Lanjouw (2003), combine the comprehensive coverage available from census data with detailed information from household surveys to produce spatially disaggregated measures of poverty and inequality. In the Thai case, data on socioeconomic outcomes for the year 2000 comes from a study by Healy and Jitsuchon (2007). Healy and Jitsuchon combined data from the 2000 Population and Housing Census with the 2000 Socio-Economic Survey (SES) and the 1999 Village Survey. They modeled household consumption as measured by the SES, using household variables available from the census (including a 20 % sub-sample measuring assets). They then constructed district and sub-district estimates of average household consumption, inequality and poverty levels with similar levels of uncertainty as the province-level estimates.[7] The data includes three measures of poverty, often referred to as the Foster-Greer-Thorbecke

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[6] The total area of Thailand is approximately 517,000 sq km (Sopchokchai 2001). Regions are defined by the National Statistical Office.

[7] Recent work by Elbers, Lanjouw and Leite (2008) tested the poverty mapping methodology in a context where the true small area values were known and found that the precision had been accurately estimated.

(FGT) measures: poverty headcount, poverty gap, and squared poverty gap.[8] Inequality is measured by the Gini coefficient, which is based on the share of total consumption earned by cumulative shares of households (higher Gini coefficients correspond to more inequality). Unfortunately, data at the appropriate spatial scale is available only for the year 2000.

[8] The poverty headcount is the share of the population that has consumption less than a defined poverty line. The poverty gap weights the poverty headcount by the distance separating the population from the poverty line. It therefore represents a measure of the amount of resources (cash transfers) that would be needed to eradicate poverty. The last measure gives more weight to the very poor by squaring the distance from the poverty line.

3.1.3 Protected areas

Protected areas boundaries come from the IUCN World Database of Protected Areas. Years of establishment for protected areas were cross-checked with information from Thailand's Department of National Parks website.[9] By the year 2000, the North and Northeast regions of Thailand included 31 wildlife sanctuaries and 57 national parks, covering 15.6 % of land area. Figure 1 shows the boundaries of the sub-districts in these regions along with the boundaries of the wildlife sanctuaries and national parks. I consider two categories of protected areas: wildlife sanctuaries (IUCN category I), which are strict reserves designed to safeguard habitat and minimize human impact, and national parks (IUCN category II), which allow for and encourage recreational use. Both legally prohibit agricultural use and resource extraction, although in reality both types of protected areas in Thailand overlap with and enclose significant human populations. For additional detail on the history of protected areas, see Appendix 1.

3.1.4 Land use

Land use outcomes for the year 2000 are from Landsat 5 satellite images interpreted by the Thai Royal Forestry Department and made available by Marc Souris (Figure 3). Land use for 1967 is from a Royal Forestry Department paper map which was geo-referenced to match current projections (Figure 2). Land use for 1973, 1985, and 1992 comes from the Tropical Rain Forest Information Center, which interpreted Landsat Multi Spectral Scanner (MSS) from a NASA mission.[10]

Thailand has lost a significant amount of forest cover in recent decades. In 1961, forests were estimated to cover 53% of the country's land area. By 2000, this had dropped to 27% percent (Royal Forestry Dept. figures, cited in Emphandu and Chettamart 2003). As can be seen from the maps of land use for 1967 and 2000 (Figures 2 and 3), large sections of forested land were permanently cleared and converted to agricultural uses. However, some smaller areas, particularly in the Northeast, have been reforested in the 1990's.[11]

[9] http://www.dnp.go.th/

[10] Tropical Rain Forest Information Center, Michigan State University (http://www.trfic.msu.edu/).

[11] Panayotou and Sungsuwan (1994) used data from 16 Northeast provinces from 1973-1982 to test a theoretical model of tropical deforestation that included demand for logging, agricultural land, and fuelwood. They found strong effects on deforestation from population, the price of wood, income, and distance from Bangkok, as well as smaller effects due to rural road density. Cropper, Griffiths, and Mani (1999) used an economic land use framework to examine the causes of deforestation at the province level from 1976-1989. They found that population pressures and road building were the most important drivers of permanent conversion from forest to cleared land but that the effect of different factors depended on the region. Puri (2006) found that decisions regarding crop adoption and crop area were somewhat sensitive to population density and property rights in a sample of villages from Chiang Mai province.

3.2 Accounting for selection and baseline differences

Given the selection process for protected areas in Thailand and the available data, I use a regression-based analysis to estimate the effects of national parks and wildlife sanctuaries on land use and local economic outcomes. I use both a standard regression technique as well as an alternate method with propensity score blocking. Both of these strategies are designed to exploit spatial variation in the locations of protected areas arising from unique natural features, while controlling for the set of fixed and pre-protection characteristics that determined designation choices and could affect outcomes.[12]

The key to constructing a plausible counterfactual group of localities is a clear understanding of the historical process for selection of protected areas.[13] In Appendix A, I describe the history of the selection process for protected areas in these regions of Thailand, as gathered from qualitative sources and interviews. The Thai situation has two main advantages that create a reasonable quasi-experimental situation.

The first is that Thailand had a politically centralized system of protected area designation during the relevant time period. While possibly problematic from a human rights or community empowerment perspective, the process of decision-making creates a useful situation because self-selection into or out of protected areas by local communities is not likely to pose a concern for estimates.

The second feature of designation is that sites were more likely to be protected if they 1) had unique natural and biological features such as caves, cliffs, waterfalls, or endemic species; 2) contained upper watershed areas; 3) were further from high quality agricultural land; 4) were forested on historical land use maps; 5) had lower potential for timber and mining. Of these factors, 2)-5) are also likely to be determinants of economic development and forest cover outcomes. Not including controls for these variables would result in serious omitted variables bias. If panel data[14] on poverty outcomes were available, most of these factors could be differenced out; since that is not possible I instead collect an extensive set of geographic data layers to control for the potential differences due to selection on factors mentioned above (see Table 1). These include slope and elevation (average and maximum); distance to boundary of upper watershed; distance to major rivers; temperature and rainfall; distance to mineral deposits; and ecosystem type.

In addition to the factors described in historical documents or previous literature as being important for selection, we might still be worried about other potential differences at baseline. In particular, political economy concerns could have pushed the government to select areas with lower expected development potential. I therefore collect additional fixed and pre-treatment

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[12] This strategy follows a growing literature that exploits plausibly exogenous sources of geographic variation while also controlling for geographic determinants (e.g. Duflo and Pande 2005, Hoxby 2000). In the working paper version (Sims 2008) I also estimate effects with an instrumental variables approach that relies on the targeting of protection to key headwaters areas. While this approach can solve potential problems of remaining omitted variables, it is unlikely to be broadly useful to the GEF because good instrumental variable situations are probably rare in the conservation context.

[13] A similar empirical strategy is employed by Ferraro, McIntosh and Ospina 2007.

[14] E.g. data from the same localities over time; also called longitudinal data.

characteristics, including distance to major and minor roads in 1962, distance to nearest major city (all established in the 1960's), distance to the Thai border, and pre-treatment forest cover. To remove initial differences in political/institutional characteristics or regional development, I include province or district-level fixed effects.[15] This set of characteristics, along with the geographic ones mentioned above, provides the best available set of proxies for pre-treatment development potential at the sub-district level.

With this set of controls in mind, the counterfactual comparison group effectively consists of localities in the same region, with similar likelihood of protection and pre-protection development potential. Conditional on these controls, the residual variation from the first selection factor mentioned above--1) unique natural and biological features--provides a plausibly exogenous source of variation in protection status. These features (examples are described in Appendix A.3.3) are plausibly uncorrelated with development potential since they could not be directly exploited for agriculture or resource extraction and private reserves were not feasible in Thailand due to land ownership laws.

Table 2 illustrates that the observable factors mentioned above that are expected to predict protection do in fact correlate well with the actual distribution of protected areas, and predict more than 35 % of the variation in protection. Regressions of the percent protected in each sub-district on the geographic and historical factors described above have the expected signs and are significant in bivariate regressions (Columns 1-9); these relationships also generally also hold in the multivariate context despite high correlation between some of the variables.

3.2.1 Region fixed effects model

Based on the logic just described, I estimate the following reduced form regression model:

$$(1) \qquad y_{itR} = \beta_1(NP_{it}) + \beta_2(WLS_{it}) + \alpha_1{}'Z_i + \alpha_2{}'X_{it-1} + \gamma_R + \varepsilon_{itR}$$

where y_{itR} is the outcome (e.g. consumption, poverty headcount) for sub-district *i*, in region *R*, and year *t* (in this case, the year 2000). NP_{it} and WLS_{it} are variables measuring the level of protection (the percent of land in each sub-district that is classified as a national park or wildlife sanctuary by time *t*). Z_i is a vector of fixed geographic controls for each sub-district, including average and maximum slope and elevation, distance to Thai national boundary, distance to navigable river, distance to mineral deposits, distance to railroad line, eco-region, average temperature and rainfall, and a dummy for being near an upper watershed area. X_{it-1} is a vector measuring pre-treatment, time-varying characteristics for each sub-district, including historical forest cover, distance to major and minor roads in 1962, and distance to major city. In addition, γ_R is a regional fixed effect (province or district). All regressions are clustered at the district

[15] A "fixed effect" adds a dummy variable for each province or district, which acts in the regression to control for fixed characteristics of each region by absorbing common variation.

level to account for possible spatial correlation in errors. The results, shown in Tables 3 and 4, are discussed below in Section 4.

3.2.2 Region and propensity score fixed effects

Traditional regression methods are potentially sensitive to choice of functional form, particularly if treatment and control groups are dissimilar (Imbens 2007).[16] I use propensity scores measuring the likelihood of assignment to protected areas to improve the above estimates in two ways: first, to select the sub-sample for which there is the best overlap between treatment and control groups and second, as an alternate method for estimation.

I use a maximum likelihood logistic model to estimate the propensity scores. This is similar to the standard logit model but allows outcomes to have fractional values (Papke and Wooldridge 1996). The variables I use to construct the propensity scores are the geographic covariates listed in the previous section (and demonstrated to be predictive in Table 2). For maximum flexibility in functional form of the propensity score estimation, I divide each of the continuous variables (such as distance from city) into groups of equal size (six or more groups) and regress on the set of dummy variables. The propensity score is thus estimated with this model:

(2) $$E(PA_i \mid S_i) = \frac{\exp(S_i \lambda)}{1 + \exp(S_i \lambda)}$$

where PA_i is the percent of each sub-district that is protected and S_i is the set of geographic characteristics that affect selection into protected areas.[17] The coefficients from this model are then used to predict an estimated likelihood of protection for each sub-district as a function of these characteristics. Similar characteristics predict the percent protected as national parks and wildlife sanctuaries, so I use only one propensity score. Figure 4 shows the propensity scores of the sub-districts on a map, with protected area boundaries super-imposed. This illustrates the locations of areas that were not protected but that had a high likelihood of protection.

In Thailand, many sub-districts had little chance of being placed in protected areas and some protected area sites do not have good controls in the unprotected group. This can be seen in Table 6, which shows the estimated propensity scores and the frequency of protection. Only a few sub-districts in the lowest propensity score group were protected, while all sub-districts in the highest propensity score group were protected. Therefore, my first use of the propensity

[16] Matching methods rely on finding good "matches" for the treated units—e.g. control observations that are the same on pre-treatment characteristics—and making comparisons directly within these sub-sets. Matching can potentially reduce bias and improve efficiency but is not feasible when there are many continuous characteristics that determine selection. In that case, propensity score techniques provide a feasible solution (Rosenbaum and Rubin 1985, Dehejia and Wahba 1999). The propensity score is defined as the conditional probability of assignment to the treatment group, holding constant a defined set of observable pretreatment variables (Imai and Van Dyk 2004). In the ideal case, units with the same propensity score have the same likelihood of assignment to treatment, which mimics the conditions for a randomized experiment.

[17] I eliminate sub-districts with a maximum elevation of 180 m. No treated units have maximum elevation < 189 m.

scores is to restrict analysis to the sub-sample where there is the best common support, or overlap between treatment and control (Dehijia and Wahba 1999). In effect this eliminates sub-districts in the lowlands, which are prime agricultural areas and the most densely settled, and a few very high-elevation sub-districts for which there are not comparison sub-districts without protection. The results are shown in Table 7 (Panel 1).

As a second use of the propensity scores, I include propensity score block fixed effects, following the approach in Jones and Olken (2007). This means that estimates are identified off of variation that is within-province and within-likelihood group. The specification is thus:

(3) $$y_{itRL} = \beta_1(NP_{it}) + \beta_2(WLS_{it}) + \gamma_R + \gamma_L + \varepsilon_{itRL}$$

Again, y_{itRL} is the outcome for sub-district *i* at time *t*, in region *R,* with protection likelihood *L*, γ_L is a fixed effect for each likelihood block (propensity score), and γ_R is a regional fixed effect. Results are shown for two different choices of common support in Table 7 (Panel 2 and 3).

3.3 Estimating protected area impacts on land use

Although the primary purpose of the paper is to study socio-economic impacts of protected areas, it is important to establish whether legal protection has resulted in real restrictions on community land use. The main mechanism by which protected areas might impose opportunity costs on local communities in Thailand is by restricting their use of land for agriculture. We should therefore be concerned with whether protected area designations are being enforced to a degree such that they are preventing deforestation that would otherwise have occurred.

I measure forest cover using detailed satellite-based land use data from the year 2000, historical satellite-based forest cover data from 1992, 1985, and 1973, and map-based measures from 1967. This new compilation allows me to estimate the effects of protected areas on forest cover using both the spatial variation described above as well as temporal variation in designation. For consistency, I first estimate potential impacts using the models described above (see Table 5, top panel, as well as Table 7 for extensions).

In addition, I compile a new panel of forest cover from 1973, 1985, 1992, and 2000. This allows me to estimate the effects of protected areas on forest cover using both the spatial variation described above as well as temporal variation in designation (Table 5, bottom panel). The simplest specification includes sub-district level and year fixed effects to take advantage of variation across time in protection:

(4) $$pctforest_{it} = \beta_1(NP_{it}) + \beta_2(WLS_{it}) + \gamma_i + \gamma_t + \varepsilon_{it}$$

where $pctforest_{it}$ is the percentage forest cover for sub-district *i* at time *t*, NP_{it} and WLS_{it} are the percentage protected in National Park or Wildlife Sanctuary, γ_i is a sub-district level fixed effect and γ_t are period fixed effects. For robustness checks, I also estimate first-differences and random effects variations of the model (Table 5, bottom panel).

4. RESULTS AND ROBUSTNESS CHECKS

4.1 Regression analysis results

I find that sub-districts with more land in protected areas were substantially poorer in 2000 than the province averages. However, after accounting for the selection of protected area locations as described above, the opposite relationship holds. This suggests that the poverty of these communities is not due to the establishment of protected areas. I find that national parks and wildlife sanctuaries in Thailand have significantly increased forest cover, but have not had a corresponding negative impact on sub-district level economic outcomes. Rather, sub-districts with more land in national parks have significantly higher consumption on average and lower rates of poverty in comparison with appropriate control sub-districts. Sub-districts with more land in wildlife sanctuaries do not have significantly different consumption levels or poverty rates than similarly remote and rugged sub-districts. Population densities are not significantly affected by protected area status. Protected areas, particularly national parks, may have increased inequality at the sub-district level, although this difference is not consistently significant across specifications.

4.1.1 Protected areas and socio-economic outcomes

Table 3 presents the results of the OLS regressions described above for the key socio-economic outcomes—average consumption levels and poverty headcounts. The first column shows the simple association between protected areas and consumption or poverty. Without any controls, there is a strong correlation between sub-districts with lots of protected land and low economic development. A sub-district with one third[18] of its land in a national park had on average 3-9 percent less consumption and 11-27 percent more people under the poverty line than other sub-districts in the region. A sub-district with one third of its land in a wildlife sanctuary had on average 5-14 percent less consumption and 18-48 percent higher poverty headcount. However, after controlling for simple correlates of land quality--province, slope, and elevation (Table 3, columns 3 and 8)--the correlations are reversed. Including the full preferred set of controls for additional determinants of selection and historical land cover (Table 3, columns 5 and 10) has a small additional effect on estimates.

The results suggest that protecting one-third of a sub-district's land with national park status led to 2-7 percent higher consumption and 4-12 percent fewer people in poverty, on average. Protecting land with wildlife sanctuary status did not have statistically significant impacts on consumption or poverty headcounts, although the signs indicate positive economic impacts. National park protection has also significantly decreased poverty as measured by the poverty gap or squared poverty gap (Table 4); wildlife sanctuary protection has not had statistically significant impacts on these measures.

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[18] The magnitudes can be framed in terms of a typical policy scenario. I consider the enclosure of one third of a sub-district in a protected area, because the median percent protected for sub-districts with some land in protected areas is 33.7 percent. The ranges are expressed in terms of the 95% confidence intervals for the coefficients.

There is some evidence that protection has increased inequality within sub-districts. The Gini coefficients are higher for both types of protected areas (Table 4) but the difference is only marginally significant (p=.07) for national parks and is not significant for wildlife sanctuaries. Finally, the estimated effects on population density (Table 4) are not significantly different from zero for either parks or wildlife sanctuaries across most specifications. Sub-districts with land in wildlife sanctuaries may have slightly higher population densities than expected.

As discussed in the previous section, I construct and use an estimated propensity score to limit the sample to those observations with common support and to make comparisons with fewer parametric assumptions. These results (Table 7) are very similar to the standard OLS estimates, even when the sample is limited to sub-districts that have high common support and comparisons are made using variation only within propensity-score block.[19]

4.1.2 Protected areas and forest cover

The regression estimates of the effects of protection on forest cover are shown in Table 5. Again, without controlling for any geographic or historical factors, a sub-district fully enclosed in a national park or a wildlife sanctuary had respectively 71-90 and 75-96 percentage points more forest cover in 2000 than all other sub-districts. Columns 1-5 show the stepwise inclusion of controls corresponding to the model in equation 1 above. After accounting for selection and historical forest cover differences, forest cover is still higher in sub-districts with more protected land. The estimated effect of protecting the full sub-district (Column 5) is 17.0 percentage points more forest cover for national parks and 21.5 percentage points more forest cover for wildlife sanctuaries. Using the panel data on forest cover from 1973, 1985, 1992, and 2000 along with changes in protection during this period produces similar estimates (Table 5, Columns 6-10). Point estimates from the panel regressions are slightly smaller in magnitude: approximately 8-12 percentage points of forest cover for sub-districts fully protected as national parks and 11-17 percentage points for wildlife sanctuaries. The results demonstrate that protected areas did prevent clearing that otherwise would have taken place and therefore did pose a significant constraint (both statistically and in magnitude) on agricultural land use. These estimates are similar in magnitude to previous studies of the impacts of protected areas on forest cover from other middle income countries as described in Section 2.4.

4.2 Robustness checks

4.2.1 Specification checks

Several alternate specifications were used to check that the results are not driven by choice of comparison group or functional form. The robustness checks are discussed briefly here.[20] The following specification checks did not meaningfully change the results:

[19] Further limiting the sample by one to one nearest neighbor matching based on propensity scores produces similar results (available from author).

[20] Robustness checks results can be found in the working paper version (Sims 2008) or are available from the author.

- Allowing for a fully flexible functional form by blocking the control variables into sets of dummies.
- Controlling for the length of time areas had been protected.
- Including earlier or later measures of historical forest cover (1967 or 1992).
- Adding district fixed effects instead of province fixed effects.
- Measuring protection as a categorical, rather than continuous variable (the results do not show a strongly non-linear or U-shaped relationship between protection and outcomes).
- Using as controls only those sub-districts with land that will be protected in the future. This is potentially useful because it restricts the comparison group only to those places that could actually be selected to become parks and uses variation in timing to identify effects.
- Excluding the longest established, flagship parks from the sample
- Excluding sub-districts that are very far from or very close to current parks.

4.2.2 Including controls for the percent of land in forest reserves

As indicated in the historical review in Appendix A, much of the control group may fall inside land that has some environmental protection through forest reserves status. Within the forest reserves, full land title and thus access to formal credit have been constrained (Giné 2005, Chalamwong and Feder 1988). If the Thai government had given full land rights to all occupants in the forest reserves, perhaps the wealth of sub-districts in some comparison sub-districts would have been higher (alternately, massive deforestation could have compromised soils and water supply). Controlling directly for the forest reserve status diminishes the estimated magnitudes but also does not significantly change the results.

4.2.3 Spatial spillovers and spatially correlated errors

The possibility for protected areas to create positive or negative environmental spillovers that might bias results has been previously described in the literature and is most recently summarized by Andam et al. (2007). With respect to forest cover outcomes, protected areas could restrict the use of land for farming, leading to negative environmental spillovers in the form of increased agricultural or residential land use in the areas just outside of the parks. Alternatively, parks could have created positive environmental spillovers by increasing alternate employment activities and reducing pressure on agricultural land. With respect to socio-economic outcomes, again positive or negative spillovers are possible. Restrictions on land use could have depressed wages due to a surplus of labor near the parks and increased nearby poverty rates, or the presence of protected areas may have increased surrounding land rents and generated new sources of income from passing tourists.

I conduct simple tests for spillovers into neighboring districts by using a spatial lag measuring the distance to the nearest protected area from each sub-district (results available from author). I do not find evidence for significant environmental spillovers to neighboring sub-districts. To the extent that there are economic spillovers, they seem to be positive, which would tend to bias the magnitude of the results towards zero since the neighbors are part of the control group. This suggests that the results on income and poverty are not explained by spillovers.

We might also be concerned that standard errors are misestimated because of spatial autocorrelation. The results presented cluster all standard errors at the district level, as noted in the tables. In addition, I also estimate standard errors using Conley's (1999) method for correcting for spatial correlation in errors. (This method is similar to the commonly used Newey-West correction for time-series data.) Using these standard errors does not change the previous interpretation of the significance of results.

5. DISCUSSION

5.1 Tourism as likely source of income

Additional income from tourism is likely to be the largest local economic benefit from protected areas in the Thai case, although community development assistance and direct employment may also have played a role.

Several pieces of evidence suggest that tourism and related community development programs associated with protected areas in Thailand are the most likely explanation for the results. First, the volume of tourists is quite large, due to the active promotion of national parks by Thailand's Tourism Authority. Official statistics show that there were more than 10 million visitors to national parks in the North and Northeast regions of Thailand in the late 1990's (Table 8 has 1998-2000 figures).[21] Including a variable measuring the number of visitors to the national parks that overlap with each sub-district shows that popularity of the parks is in fact positively associated with higher consumption levels and lower poverty rates (see Table 8). Second, the most plausible reason for the difference in results for wildlife sanctuaries and national parks is the higher volume of tourists to the parks. Other potential benefits such as increased non-timber forest products or increased local water quality should be similar for wildlife sanctuaries and parks, conditional on controls.

Third, although there are many documented negative interactions between communities and the Royal Forestry Department, there are also institutional mechanisms to help locals gain from tourism (Emphandhu and Chettamart 2003, RECOFTC 2005, Vandergeest 1996b, Dearden et al. 1996). There are no mechanisms for general direct compensation to households affected by protected area status. However, in 1996 a new legal provision required parks to give sub-district administrations a portion of their revenue from tourism receipts (Pipithvanichtham, date unknown). The RFD has supported training courses to help local people benefit from park-oriented employment such as being a tour guide and providing lodging. Chettamart (2003) notes that there are at least 50 documented communities who used national parks as the key destination for tourists. Controlling for the length of time since establishment of the protected areas suggests that the older national parks are associated with larger differences in consumption and poverty rates. The national parks that have been in place the longest are associated with the largest gains

[21] In 1996 there were an estimated 13 million visitors to national parks throughout the country (Pipithvanichtham, RFD document, date unknown) and an estimated $1.5 million in U.S. dollars of direct park revenues. Israngkura (1996) estimated 100,000 visitors taking treks in the North of Thailand. In the late 1990's there were over 600,000 visitors annually to Doi Inthanon, one of the most popular parks in the North (Wheeler, 1998).

in consumption. This is consistent with a story where it takes some time to promote and develop tourism around parks (although it is also consistent with a story where the most attractive features were included in the early parks).

Finally, while the estimated effects are significant in terms of percentage changes in consumption levels and poverty headcounts, these numbers are fairly small in dollar terms. In 2000, the average monthly per capita consumption for the whole sample was approximately 1530 Baht. A 5 % increase thus represents approximately $2 US dollars per month, given exchange rates around that time (author's calculations). This does not seem an inconceivable amount to earn from providing lodging, food, handicrafts, etc. Tourism is likely to be the only economic benefit large enough to explain the results, but other sources of income may have played a role. A small number of locals are directly employed by the Royal Forestry Department, which did have significant budgetary resources throughout the 1990's.[22] Royal Projects, which focus on local development and are initiated by the Thai royalty, may have been differentially targeted to protected areas. NGO's have also sponsored several integrated environment and development projects in and near the protected areas.

5.2 Alternate explanations: migration or political economy?

A possible alternative explanation is migration: perhaps the remaining inhabitants of protected areas are richer than inhabitants of similar areas because the poorest moved out. There has indeed been significant migration in and out of rural communities in Thailand since the 1960's, with a wave of migration and population growth in frontier rural areas in the 70's and 80's and then migration out of rural areas and into cities in the 1990's. But if the protected areas were simply supporting fewer numbers of richer inhabitants, we would expect to see significantly lower population density in sub-districts with protected land. This pattern is not found in the data—population densities in 2000 are not significantly different across specifications. As an additional robustness check, I calculate the change in population density for each sub-district from 1990 to 2000 using global population data available from CIESEN (2005). This coincides with the period of most strict policy enforcement and therefore possible migration away from protected areas. This measure is also not significantly different for sub-districts with land in protected areas.

A second possible explanation is that unobservable characteristics missing from the regression analysis such as political influence could explain the results. To get the results we observe, protected areas would have had to be placed more often in places with strong economic potential. However, as described in Appendix B, this is not consistent with case study descriptions of the gazetting process, which suggest that protected areas were often placed in areas with the least economic potential and political influence. We can also see statistically in table 2 that protected areas were more likely to be placed in areas with marginal land quality and

[22] Vandergeest 1996b calculates that the RFD's share of total government expenditures in 1993 was 0.93%.

areas that are more likely to be home to ethnic minority groups (land with steeper slopes, higher elevations).[23]

6. CONCLUSIONS

6.1 Summary

Simple statistical comparisons show that protected areas in Thailand are clearly associated with high levels of poverty. However, this study confirms the importance of accounting for the designation process before drawing conclusions about the links between conservation interventions and development outcomes. In this case, controlling for geographic characteristics and prior forest cover <u>reversed</u> the sign of the relationships between protected areas and poverty. This suggests that increased economic benefits from protected areas have been high enough to offset the costs of limiting the area available for agricultural production at the community level. From a theoretical standpoint, this case suggests that simple economic models of the effects of protected areas on local economic outcomes should at least consider the possibility of returns from a new income-generating sector.[24]

However, this study does not lead to overly optimistic conclusions about protected areas, even in Thailand. The fact remains that the inhabitants of Thailand's protected areas (as well as the residents of other rural and remote areas) lagged significantly behind those in the lowlands of the same provinces. The bulk of environmental benefits from watershed and biodiversity conservation may still accrue disproportionately to downstream districts and the global community. Even if communities end up materially better off as a result of protected areas this does not diminish social justice concerns where communities may have lost access to traditional resources or have been harassed or forcibly relocated. While the overall economic impacts of tourists to the protected areas have been positive, the results suggest that more tourists are also associated with higher levels of inequality. The gains from new tourism opportunities may have gone disproportionately to already high income groups, even though overall poverty rates and the poverty gap also decreased. Future work should continue to understand the conditions under which formal redistributive policies or payments for environmental services schemes are appropriate.[25]

We should also exercise caution in extrapolating from Thailand's experience to other countries without considering the potential differences in social and political institutions. The potential for protected areas to generate local economic growth will depend on investment in opportunities such as tourism that are based around environmental amenities. Success will also

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[23] A map overlaying protected area boundaries with the location of ethnic minority villages as mapped by McKinnon and Bhruksasri (1983) for Northern Thailand is available from the author upon request. There was no clear pattern seen, with the major ethnic groups represented both inside and outside of the protected areas.

[24] This has been previously proposed in the literature, including on Thailand: Albers (2001) assumes positive externalities from Khao Yai NP in Thailand on nearby resorts, and allows for the reality that agricultural neighbors do collect fuel and firewood.

[25] See e.g. Wunder (2007) and Jack et al. (2008).

depend on whether there are institutional mechanisms that ensure that local communities can gain. Thailand is a middle income country which has enjoyed rapid economic growth and a relatively stable society in the past forty years. Thailand's government has invested considerable resources in building and maintaining its parks system as well as promoting national tourism in general. In other situations we may find that the local benefits of parks have not outweighed local costs.

6.2 Evaluating the impacts of protected areas

6.2.1 Evaluating the results of support for Thai protected areas

Thailand contains important biodiversity hotspots and has one of the largest protected area complexes in Southeast Asia. The GEF has funded several regional environmental initiatives, which have included Thailand, and which have also been relevant for protected areas (e.g. "National Performance Assessment and Subregional Strategic Environment Framework in the Greater Mekong Sub-region" and the "Global Alternatives to Slash and Burn Agriculture" projects). The GEF Small Grants Program has also supported several projects in communities that overlap with protected forest and marine areas throughout Thailand. To date, the GEF has not been involved directly in substantial funding for specific protected areas in Thailand. This is due to the delay by Thailand in ratifying the Convention on Biological Diversity (it was ratified in 2003[26]).

Since the GEF has not funded specific protected areas in Thailand, this analysis concentrates on the protected area system as a whole. The approach to evaluating a protected area system conducted for this project considers parks established between 1964 and 2000. More recent socioeconomic data at the appropriate scale are not yet available, but the data and methods from this study could serve as an important baseline for future work. Support is currently being given by GEF to a project on "Catalyzing the Sustainability of Thailand's Protected Area System."[27] The objectives of this project include increasing management capacity, developing sustainable financing methods for the protected areas and improving local partnerships and regulations in order to reduce conflict around the protected areas. A follow-up analysis using the next round of Thai census data in 2010 would be ideal to study the impacts of protected areas (including those now supported by the GEF) on socio-economic development from 2000-2010.

An additional goal of the new GEF-funded project is to improve the targeting of protected area budgets based on local need. The methods of spatial overlay demonstrated here may be useful for that goal. Updated poverty maps for Thailand could be used to help understand where vulnerable communities are located, and to improve resource targeting based on that information in combination with other geographic data on biological hotspots, ecosystem types, etc.

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[26] According to Thailand's Office of Natural Resources and Environment Policy and Planning, http://www.onep.go.th/bdm/National-Report/Implementation_eng.html

[27] Project Identification Form, 2007. (See GEF online project database).

6.2.2 Future evaluation of GEF investments in protected areas

The methods demonstrated here can also be of use in evaluating GEF support for specific protected area projects in other countries. Poverty maps have been constructed for a large number of countries; similar analyses could be undertaken for other protected area systems.[28] Some of these are or will soon be updated after new rounds of data collection. As the next set of poverty mapping data is available, longitudinal analysis may be possible for several countries. This type of study could help the global environmental community to greatly improve our understanding of medium-term economic impacts of protected areas. Such analysis would be particularly useful in those countries where the system of protected area designation creates reasonable comparison groups of communities.

Future use of the comparison-group based methodology described in this project can ideally complement case studies and household level work by providing a broader overview of impacts across a larger number of sites. A challenge for future methodology development is to use new large sample analysis to better understand the conditions under which joint gains in environment and development outcomes from protected areas are possible.[29] What roles do infrastructure development, education, agricultural intensification, or institutions play in mitigating the opportunity cost of land restrictions and in capturing tourism benefits? How have protected areas affected a broader set of environmentally and socially significant outcomes, including biodiversity, water quality, and health? The limitations of current data to shed further light on these questions in this study suggests the need for additional long term monitoring efforts which combine environmental, socio-economic and institutional approaches.

[28] Two main sites with information on poverty mapping analysis are: 1) World Bank: http://www.worldbank.org/povertymapping and 2) Columbia University SEDAC/CIESEN has several downloadable data sets: http://sedac.ciesin.columbia.edu/povmap/.

[29] E.g. Brandon et al. (2005) develop new methods for conservation planning that evaluate potential tradeoffs between agricultural suitability and biodiversity protection. Muller and Albers (2004) model how different types of enforcement and associated responses may depend on the market opportunities nearby.

APPENDIX A: PREVIOUS EMPIRICAL WORK ON LOCAL IMPACTS OF PA SYSTEMS

Our current understanding of the local effects of protected areas is limited in several ways. First, most studies consider only the impacts of protected areas on environmental outcomes. Second, of those studies that do consider social impacts, most have estimated expected costs or benefits in advance of protected area establishment rather than analyzing what has actually happened. Finally, the set of retrospective studies of economic outcomes is incomplete. Most do not include a control or comparison group and focus on a small number of potentially non-representative case sites or only use data from developed countries.

A.1 Empirical studies of environmental effects

Several studies indicate that protected forest areas have had a positive environmental impact (Naughton-Treves et al. 2005, Bruner et al. 2001, Nepstad et al. 2006, Sanchez-Azofeifa et al. 2003). However, the amount of avoided deforestation that can be attributed to legal protection versus the tendency to establish parks in more remote and rugged areas is disputed. Studies that control for selection have found more modest environmental impacts of protection. Deininger and Minten (2002) found that protected areas in Mexico decreased deforestation probabilities by 10 – 21 percentage points after controlling for geographic characteristics, tenure arrangements and socio-economic variables. Chomitz and Grey (1996) found that national parks and private reserves in Belize had 4.5 percentage points less clearing than expected according to their model of land use change. Andam et al. (2007) finds that the magnitude of avoided deforestation that can be attributed to protected area status in Costa Rica is 10 percent or less.

There is a growing body of evidence demonstrating that local institutional arrangements play a key role in the effectiveness of forest conservation.[30] Where both state and local institutions are weak, protected areas may be doing little to stop conversion pressures and logging.[31] Assuming that deforestation pressures will continue in many countries, stronger enforcement or a different institutional approach may be needed to maintain similar levels of forest cover in protected areas that until now have been relatively undisturbed.

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[30] The existence of local institutions that have been able to overcome collective action problems and safeguard natural resources has been broadly demonstrated across the globe (Gibson, McKean, and Ostrom 2000, Ganjanapan 2000, Agrawal and Ostrom 2001). Hayes (2006) finds that institutional variables including rules for forest product uses and the ability for local users to influence the process are significantly correlated with better forest condition. One conclusion of a recent WWF report (2004) on management effectiveness for over 200 forest protected areas was that efforts to manage local communities around protected areas were substantially more challenging than efforts to establish legal protections or boundary demarcations. For additional evidence of local institutional effects on forest resources in Mexico see: Alix-Garcia (2007), Alix-Garcia, de Janvry, and Sadoulet (2005), Antinori and Rausser (2007).

[31] For example, Curran et al. (2004) found that in Indonesia between 1985 and 2001, Kalimantan's protected lowland forests showed deforestation rates of more than 56 percent, and Nelson, Stone and Harris (2001) found that legal protection of a national park in Darien province, Panama, had little effect on land use change.

A.2 Local costs and benefits of protection: prospective studies

Prospective analyses have generally predicted that the local costs of protecting land in developing countries are likely to be large in comparison to local incomes. Shyamsundar and Kramer (1996) used contingent valuation to measure willingness to accept compensation for the loss of using forest land by the rural population surrounding a newly-established national park in Madagascar, finding a mean estimated willingness to accept of $50 per household per year. Ferraro (2002) estimated opportunity costs using the benefits derived from agriculture and forest products use prior to the establishment of another protected area in Madagascar. He found that annual costs per average household in the area were likely to be $19 to $70 over a sixty-year horizon, compared to average annual GNP per capita in Madagascar of approximately $200.

On the benefits side, several studies have focused on the potential local economic gains from forest protection through increased income from non-timber forest products or sustainable forestry schemes. Unfortunately, there is little evidence that these are likely to provide enough income to significantly boost material outcomes (Sunderlin et al. 2005, Wunder 2001, Richards 2000) or to substantially reward local biodiversity conservation (Brandon, Redford and Sanderson 1998).[32]

Prospective studies comparing costs and benefits at the country level or for single park-level case studies have generally predicted that protected areas will impose net local costs (Norton-Griffiths and Southey 1995, Ruitenbeek 1992, Azzoni and Isai 1994, Pattanyak et al. 2007). In the last decade many developing countries have substantially increased their park entrance fees and pursued new sources of funding to cover the costs of conservation, possibly in response to these expectations of high local net costs.[33] Additional studies are needed as the way in which economies shift in response to protected area policies may be significantly different than expected.

A.3 Local costs and benefits of protection: retrospective studies

To date, there are few quantitative, large-scale studies of the effects of protected areas on local economic development.[34] Case studies using changes over time or financial flow analysis have found evidence for both positive and negative impacts of protected areas on local livelihoods (e.g. Fortin and Gagnon 1999, Amend, Gascon and Reid 2007, Scherl et al. 2004, Wells and McShane 2004, Norton-Griffiths 1996). Several cases of displacement of local people and high perceived local opportunity cost have been documented around the globe (Geisler and de Sousa 2001, Ghimire and Pimbert 1997, Rudd 2004, Brechin et al. 2003, Kaimowitz, Faune and Mendoza 2003, Scherl et al. 2004).

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[32] Tropical forests might also serve as "safety nets," providing temporary income or subsistence materials in times of macroeconomic crisis (Wunder 2001, Pattanayak and Sills 2001, Lebel, Garden et al. 2004), although it is not clear whether this capacity would be strengthened or reduced by protection.

[33] Currently, this debate centers on whether and how to compensate tropical nations for contributing to reductions in carbon emissions through avoided deforestation (e.g. Heal and Conrad 2006).

[34] The need for empirical work on the actual impacts of conservation interventions in general is highlighted by Ferraro and Pattanayak (2006), Agrawal and Redford (2006), and Brockington et al. (2006).

The few retrospective empirical studies with clear comparison groups examine only developed country experience. Interestingly, these find little or no effect of protection on local economies, despite similar popular concerns that protection will damage local economies. Lewis, Hunt and Plantinga (2002, 2003) test for an effect of public conservation lands on employment, migration, and wages in counties of the Northern Forest Region in the United States (parts of Minnesota, Wisconsin, New York, Vermont, New Hampshire, and Maine). They find no significant effects on employment or wages from either a higher share of the land base in public conservation uses or from decreases in public timber harvests that are a result of a change in federal policy. Duffy-Deno (1998) finds no effect on county-level resource-based employment of wilderness area designations in the states of the intermountain western United States.[35] In summary, it is clear that our knowledge of the actual economic effects of protected areas in developing countries is incomplete.[36] This study seeks to contribute to that gap.

APPENDIX B: STUDY AREA AND BACKGROUND

B.1 Protected areas in Thailand: history

Thailand was one of the first developing countries with significant tropical forest resources to establish a large number of protected forest areas. It is a useful case in which to study the effects of protected areas because of the significant amount of land area under protection, the length of time protected, and the availability of data at small spatial scales. In addition, it is possible to take advantage of the centralized process of designation of protected areas and exploit plausibly exogenous residual variation in protected area locations from unique physical and biological features. This section reviews the pertinent aspects of protected areas in Thailand, including their legal definitions, the history of selecting protected areas, and the general pattern of enforcement.[37]

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[35] A related literature evaluates conservation set aside programs which compensate landholders for making changes to land such as planting grasses or tree cover to reduce erosion. Perhaps surprisingly, evaluations of programs in the U.S. and China have also not found evidence of negative impacts on local economies (Sullivan et al. 2004, Xu et al. 2005).

[36] Some additional empirical work on the effects of protected areas in developing countries is in progress. A recent World Bank report cites forthcoming work by Gorenflo and others at Conservation International that demonstrates that protected areas in Madagascar have been effective at reducing deforestation but despite integrated conservation and development projects and investment in promoting tourism, incomes have not improved substantially (Chomitz 2006). Work is also in progress to monitor households in Gabon (Wilke et al. 2006) as protected areas are established; and Kwaw Andam and Paul Ferraro have preliminary results from an analysis of Costa Rica's protected area system (pers. comm. 2008).

[37] I rely on information from a broad set of secondary sources referenced in the text, as well as personal communication from individuals with experience in Thailand. These include Jeff McNeely, IUCN, Louie Lebel and Po Garden, Unit for Social and Economic Research, Chiang Mai University, Dr. Benchaphun Ekasingh, Chiang Mai University, Dr. Pornchai (former RFD official), Mr. Veerasak (current RFD official, Chiang Mai Province).

B.2 Legal definitions of protected areas

Wildlife sanctuaries are the most strictly protected areas in Thailand, corresponding to The World Conservation Union (IUCN) Category I designation of strict nature reserve or wilderness area (ICEM 2003). The legally established goal of wildlife sanctuaries is to protect "land declared for the conservation of wildlife habitat so that wildlife can freely breed and increase their populations in the natural environment" (WARPA 1960 as cited in Dixon and Sherman 1990). Education and research are permitted in wildlife sanctuaries but large-scale recreational tourism, agriculture, and industrial or commercial activities are not officially legal. Some small scale eco-tourism activities have been permitted (Chettamart 2003).

National parks are land "preserved in its natural state for the benefit of public education and enjoyment" (NPA as cited by Dixon and Sherman 1990) and fit IUCN Category II guidelines (ICEM 2003). Officially, all unauthorized hunting, clearing, collection of forest products, residence, mining and grazing are prohibited, but tourism has been encouraged and promoted by the government.

Thailand also designated non-hunting areas and forest parks (IUCN categories VI and III respectively), but these represent very small areas of land. However, significant areas of land were designated as national forest reserves and more recently as Class 1 watersheds, by zoning systems which overlap with the protected area designations (ICEM 2003).

B.3 The process and politics of protected area designation

The history of protected area designation is crucial for the empirical strategy of using spatial variation in protected area locations to identify effects. I argue here that the centralized nature of political power and decision-making in Thailand meant that local residents and sub-district level officials had very little influence on where protected areas were located. I also explain why areas were more likely to be included if they had unique physical and biological features, were important for national watershed protection, had high levels of historical forest cover, had less favorable agricultural conditions, and were closer to national borders and further from mineral and timber resources.

B.3.1 Legal basis and general timing of establishment

Legislation establishing the basis for a protected areas system in Thailand was passed in 1960 (Wild Animals Reservation and Protection Act) and 1961 (National Parks Act). Primary input into the initial plans came from two key figures: Dr. Boonsong Lekagul, a Thai, and George Ruhle from the U.S. Park Service. Dr. Boonsong was a medical doctor, big-game hunter, and conservationist who lobbied for the establishment of protected areas, founded the first wildlife society, and researched and wrote the first field guides to wildlife in Thailand (Vandergeest 1996b, Bird Conservation Society of Thailand undated, Wildlife Fund Thailand undated, Ekachai 2007, McNeely and Sochaczewski 1995). However, he had a difficult time convincing government authorities of the importance of wildlife conservation until General F.M. Sarit came to power in a military coup in 1958. Through political connections and apparently a helicopter tour of the ongoing destruction of the forest in the Dong Phaya Yen mountains (Ekachai 2007), Dr. Boonsong convinced General Sarit of the national importance of establishing a parks system (Vandergeest 1996b, Roth 2004a).[38]

In 1959 and 1960, Dr. Boonsong toured Thailand with George Ruhle from the U.S. National Parks Service to identify and plan potential sites and laws for a park system (Ruhle 1964, Vandergeest 1996b). During this visit, Dr. Ruhle located and recommended the most promising national sites for protected areas, primarily on the basis of spectacular natural features and wildlife. All of the sites he recommended would later become parks, and they form the basis of some of the largest flagship protected areas. Many of these sites were former research areas and hunting sites of Dr. Boonsong, who had lived and worked in many parts of Thailand (McNeely and Sochaczewski 1995, Wildlife Fund Thailand, undated).

National parks and wildlife sanctuaries continued to be established in the 1970's, 80's and 90's, primarily under the impetus and direction of the Royal Forestry Department, but also with encouragement and funding from Thai and international conservation groups (Buergin 2001, Vandergeest 1996b). Many of the largest areas were set aside in major pushes in the 1970's and 80's, with smaller nearby areas later.[39] There have not been any substantial changes to the laws governing national parks and wildlife sanctuaries areas since they were established (Emphandhu and Chettamart 2003). As outlined in further detail below, while influential commercial or private interests powerful enough to have sway in Bangkok may have influenced the process of protected area designation, there was little input from districts, sub-districts or villages. The process of selecting initial and later sets of parks was heavily centralized[40] and relied largely on drawing boundaries on maps following contours and historical forest cover.

B.3.2 Centralized selection process: maps and forest cover

There is repeated documentation in case studies of existing communities or community lands that were enclosed by protected areas without consultation (Vandergeest 1996b, 2003, Dearden et al. 1996, Roth 2004a, 2004b, Delcore 2007, Thomas et al. 2004, ICEM 2003). The National Report on Protected Areas and Development (ICEM 2003) which was written in partnership with Thai government agencies states: "When PAs were established, the existence of large numbers of local communities living within their boundaries was not considered" and "often consultation has been cursory and ad hoc." Vandergeest (2003) describes a case in which the borders of a park appeared to be drawn along the contour lines from 1:50,000 military topographic maps, with some adjustments for existing forest cover. He suggests that the aerial

[38] The Royal Family in Thailand has also strongly supported environmental conservation throughout this period (Bangkok Post 2007).

[39] See Emphandhu (2001) for the details on number and type of areas gazetted under each National Economic and Social Development Plan period. By 2001, the total was 152 National Parks and Wildlife Sanctuaries nation-wide, covering approximately 15% of total land area.

[40] The official process for designating new national parks and wildlife sanctuaries stipulated that proposals for new protected areas went through a national committee. If the area for protection was approved by the committee, it would be taken to the cabinet and if there were no major objections, the cabinet would usually pass the proposal (Dixon and Sherman 1990).

photographs available to central planners would have allowed them to distinguish between paddy rice and forested areas, but not between "natural forest" and fruit trees, rubber trees, or the fallow areas which would mark human uses of sloping and upland areas.[41] Discussing Doi Inthanon National Park, Dearden et al. (1996) observe that "little attention was given to the presence of hill tribe populations when the park was first designated." Roth (2004a, 2004b) and Thomas et al. (2004) document continued conflict in 2001 between locals and the Royal Forestry Department over Mae Tho National Park. This park would enclose communities, allowing only for small buffer "holes" in the park around the villages. Delcore (2007) documents the case of Doi Phuka National Park (established in 1999) which enclosed one entire community and agricultural land from several others.

In addition, most of the land that later became national parks and wildlife sanctuaries was land already designated as national forest reserves and which therefore belonged to the government (Vandergeest 1996a, 1996b, Fujita 2003). The forest reserves designation process had also often ignored local current realities and relied heavily on maps and images indicating historical forest cover (Giné 2005, Fujita 2003, Vandergeest 1996a, Sato 2000, Chalamwong and Feder 1986, 1988). One reason for this was that the Royal Forestry Department had strong bureaucratic incentives to demarcate forest reserves whether or not they actually contained forest. Otherwise, occupants of cleared land could apply for land title and these lands would be transferred to the jurisdiction of other ministries (Vandergeest 1996a).

Sub-districts had little input because administrative power in Thailand was (and largely still is) held by the national government. Provincial governors and district officers were appointed by the national government (Booranasanti 2001, Puntasen 1996, Sopchokchai 2001). Provincial and district agencies, including the Royal Forestry Department, were also staffed by appointees from the national agencies (Sopchokchai 2001).[42] Although sub-districts had locally elected officials, their powers were quite limited (Sopchokchai 2001). Sub-district development plans and budgets, including items related to environmental management, required central approval (Tummakird 2001). Furthermore, the divisions of the Royal Forestry Department that administered the parks system were governed directly from Bangkok (Vandergeest 1996b).

A centralized process of designation was politically feasible also because the main supporters and designers of conservation were geographically divorced from the proposed protected areas. Groups in Thailand in the 1980's and 90's that were strongly in favor of conservation tended to be from the urban middle-class and elite (Hirsch and Lohmann 1989). In addition, funds for national parks and wildlife sanctuaries available from international sources gave the Royal Forestry Department and the Thai government strong incentives to quickly grow the parks system (Vandergeest 1996b).

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[41] McNeely also confirmed that this type of military map and some photos were the main tools used in laying out protected areas.

[42] Only in 1997 was some power shifted to a new, overlapping form of elected provincial government (Provincial Administrative Organizations).

B.3.3 Natural features and intact habitats

By law, the official criteria for selecting national parks included size (greater than 10 km sq.), scenic beauty, biological diversity and recreational opportunities, and for wildlife sanctuaries the number and types of species, particularly the presence of endangered species and critical habitats (Dixon and Sherman 1990, ICEM 2003). Natural features provide a useful source of variation in park locations, because conditional on other geographic factors, they are unlikely to be correlated with socio-economic outcomes except by being enclosed in parks. The main goals of the early survey teams planning protected areas in Thailand (Ruhle 1964, McNeely, pers comm) were to find areas with unique natural features worth protecting and scenic spots with tourism potential. This included sites with attractions such as waterfalls, caves (which also play an important religious role in Thailand), limestone and sandstone cliffs and the country's highest mountain tops.[43] Many sites were also chosen to protect endemic species of flora and fauna—species that do not exist anywhere else in the world. Since these were often difficult to locate, historical forest cover often served as a proxy for less disturbed habitat locations (McNeely, per comm).

B.3.4 Watershed protection

A second goal for protected areas was to ensure the protection of key water resources (Vandergeest 2003, Hirsch and Lohmann 1989). The ICEM 2003 report states (p.20), "Water resource and irrigation development has been a significant contributor to Thailand's domestic and export agriculture. . .the country has become one of the world's most important exporters of agricultural products, and is consistently among the top two or three rice exporters. . .Protecting forest areas conserves national water resources that sustain agricultural and industrial production."

In particular, attention was given to the headwaters, or extreme upstream points of major tributaries. At these points, rainwater flowing across the ground collects into small streams. The conventional wisdom is that headwaters are particularly susceptible to sedimentation from deforestation and erosion and such justification is clearly given in Ruhle's 1964 report as well as

[43] In his report on his activities and duties in Thailand, Dr. Ruhle wrote: "I was to concern myself with problems relating to conservation of endemic flora and of rare and vanishing species of wildlife" (Ruhle, 1964). He also describes several specific features. In Thung Salaeng Luang: "The very rugged limestone crags near Ban Mung. . .should be included as a scenic feature. . ."; in Doi Inthanon: "The mountain possesses fine scenery, waterfalls, streams, and representative tracts of several types of dipterocarp forests"; "Orb Luang is a picturesque, deep, narrow gorge of the Nam Mae Chaem, the like of which I saw nowhere else in Thailand, nor was anyone able to tell me of a similar feature." Unique natural features can be found in the other parks and sanctuaries as well, as documented by Cubitt and Stewart-Cox (1995). For instance, the Phu Hin Rong Kla National Park contains a notable sandstone feature; the Phu Luang Wildlife Sanctuary and the Phu Wiang National Park are the sites of rare dinosaur fossils. The Phu Kradeung National Park contains an oddly bell shaped mountain with a unique flat top plateau containing endemic high-altitude plants. The Omkoi wildlife sanctuary contains Doi Montjong, a ridge that resembles a lion's head and is home to the goral, a type of goat-antelope, as well as the Burmese Yuhina and several other rare birds. The Lum Nam Pai Wildlife Sanctuary contains a cave site with a unique ecosystem that is important to both archeologists and biologists.

subsequent studies.[44] The focus on watershed protection has been a constant theme throughout the history of Thai protected areas.[45]

B.3.5 Agricultural, logging and mining interests and national security

Dixon and Sherman (1990) note that the major constraint on protected area selection was whether the area contained any previously granted timber or mining concessions or was already legally owned by title under the land code—in other words, flat lowland agricultural areas.[46] They also characterize the process as one of picking areas that did not have powerful counterclaims: "Little or no attempt is made to quantify benefits. An area largely succeeds or fails based on the strength of the arguments against it." In a few cases, wildlife conservationists were able to protect low-lying, fertile areas that would have been good for both agriculture and wildlife. In the case of the Thung Yai and Huai Kha Khaeng wildlife sanctuaries, conservationists were able to overcome strong mining and logging interests partly because of a chance helicopter crash which revealed an illegal hunting party including senior military officers, businessmen, and family members and provoked national outrage (Buergin 2001). However, the majority of protected areas in Thailand are located on more marginal agricultural lands with steeper slopes and higher elevations.

Although not published as an official reason for locating parks, national security concerns may also have played a role in the political economy of site decisions.[47] Parks along the borders would have had the dual role of minimizing disputes with neighboring countries over the exact location of the border, as well as locating additional loyal personnel in places with potential flows of immigrants or communists (Roth 2004a, Thomas 1996, Hirsch 1993). Part of the control of outlying areas was also aimed at ethnic minorities who had traditionally inhabited mountainous areas in the North and West of Thailand. The Thai government made a concerted effort to "settle" and "develop" these groups by organizing them into official villages, pressuring them to stop shifting cultivation (and in some cases opium cultivation) and to assimilate them

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[44] Ruhle's report states: "This area is a vital watershed as well, and should be fully protected as such" (referring to Thung Salaeng Luang, p.5); "This uplift is part of the rim of the Khorat Basin, which has the most precarious water reserves of the entire country. Any use that may possibly affect the delicate water supply adversely should be scrutinized with caution." (p.6 referring to Khao Yai); "Protection and preservation of the watershed is of prime importance. Forest burning by squatters must be prohibited and stringent punishment meted out to culprits" (referring to the Mae Chaem river in Ob Luang Park, p.12). In 1993 a study recommended that 38 percent of the country, particularly the head watersheds, should be maintained as forest to keep the annual water flow (ICEM 2003 p.81). A 1988 study estimated that the watershed protection services provided by Khao Yai National Park were worth 1.27 million USD per year (Dobias et al. 1998).

[45] In 1988, several hundred villagers died in mudslides in Southern Thailand which were blamed on deforestation in these areas and gave renewed strength to arguments to maintain forest cover on key steeply sloping areas (Hirsch and Lohmann 1989, Cubitt and Stewart-Cox 1995) and ultimately led to the nation-wide logging ban in the early 1990's. Roth (2004) describes how Forestry Dept. officials in the Mae Tho National Park (which is part of a watershed that flows eventually to Bangkok) cited watershed conservation as a main conservation goal.

[46] This is also confirmed by a translation of the National Parks Act (Chettamart 2003).

[47] The Royal Forestry Department and the military and border police have periodically shared resources and cooperated (Vandergeest 1996a, 1996b, Buergin 2001).

into market-oriented production (Roth 2004a,b). To the extent that site selection was directed towards areas with these traditionally disadvantaged groups, this would tend to bias the results against finding a positive socio-economic effect.

B.4 Enforcement

The implementation of legal restrictions in protected areas has varied somewhat across administrations (see Vandergeest 1996, Thomas 1996, Kaosaard 2003). Enforcement was relatively more lax in the 1960's and 70's, but increasing in the 1980's and 1990's. A previous study using land cover data from 1986 found that national parks and wildlife sanctuaries, considered together, did not significantly reduce the probability of forest clearing, although wildlife sanctuaries alone may have reduced clearing (Cropper et al. 2001). Since then, however, enforcement has significantly increased as the Royal Forestry Department shifted mission from protecting logging interest to conserving forests (Vandergeest 1996b).

Thailand's national parks and wildlife sanctuaries do have substantial numbers of inhabitants and overlap with human settlements, although this is incompatible with the legal definitions of protected areas (Emphandhu and Chettamart 2003). The ICEM report (2003) estimated that more than 500,000 people were living inside national parks and wildlife sanctuaries.[48] Initially weak enforcement probably encouraged settlement in protected areas in many cases. Dearden et al. (1996) documented both in-migration to the park and population growth in Doi Inthanon since the park was established.[49]

There are a few documented cases of actual forced resettlement of villages from inside of protected areas to areas in the lowlands outside the park boundaries deemed more "suitable" by the Forestry Department. But two large proposed resettlement schemes (the "Green Northeast" program and the "Khor Jor Kor" program) failed due to overwhelming opposition from NGOs, student groups, and residents (Buergin 2001).

In sum, large scale, forced migration out of parks has not occurred in Thailand. Most enforcement has concentrated on limiting communities' use of protected areas rather than stopping it altogether (Delcore 2007, Roth 2004a, Roth 2004b, Dearden et al. 1996, Emphandhu 2003, Buergin 2001). These limitations take the form of prohibitions on hunting or collecting certain types of forest products, and on restricting the amount of land under cultivation (e.g. Delcore 2007, Dearden et al. 1996, Roth 2004a,b, Buergin 2001, Fujita 2003).

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[48] In 1998, some limited recognition of communities living in PAs before their gazettal was made through a cabinet resolution (ICEM 2003).

[49] Vandergeest 1996b documented conflicts over resources within park boundaries in Thailand and argued that the land within Thailand's protected areas that was claimed and used by local communities should be returned to locals. A response by Dearden, Chettamart and Emphandu (1998) argued that Vandergeest's case was not typical and that in many cases villagers occupied the protected area after it was gazetted. They also argue that for Khao Yai, at least, illegal activities are declining partly as a result of development approaches that seek to bring surrounding communities out of poverty.

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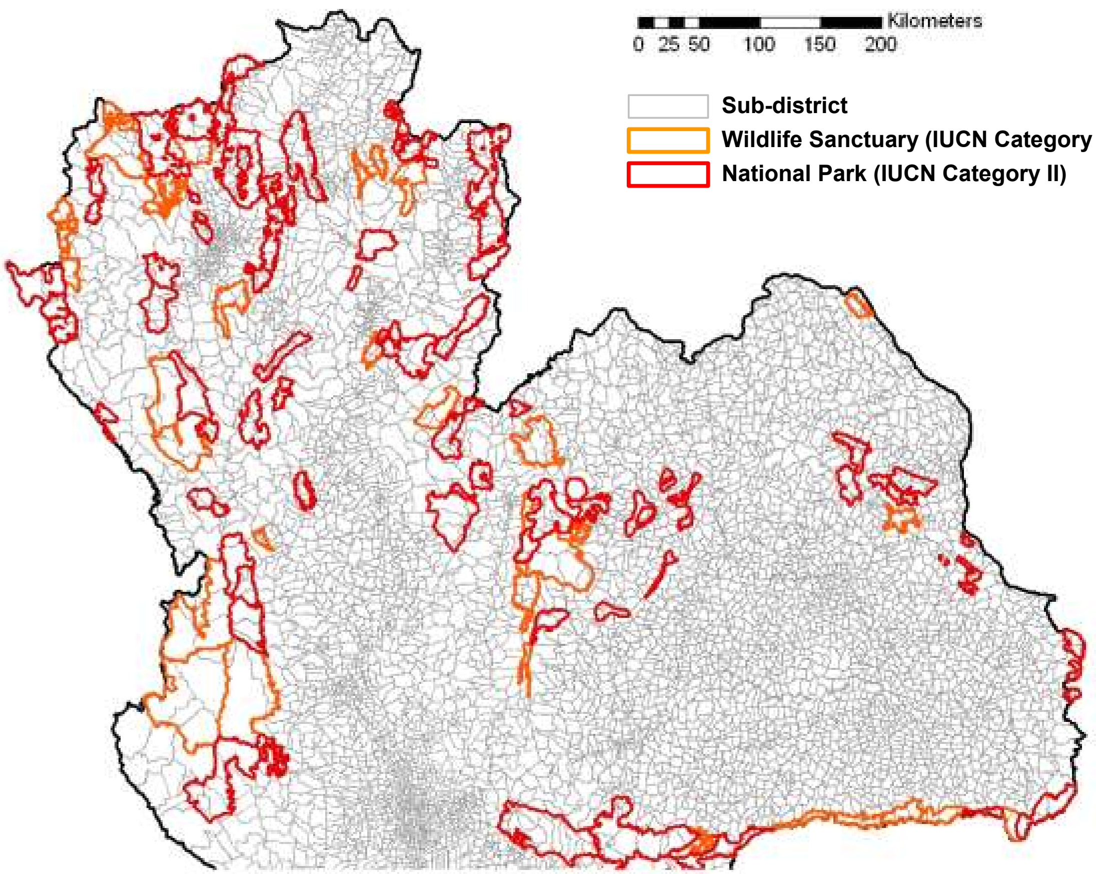
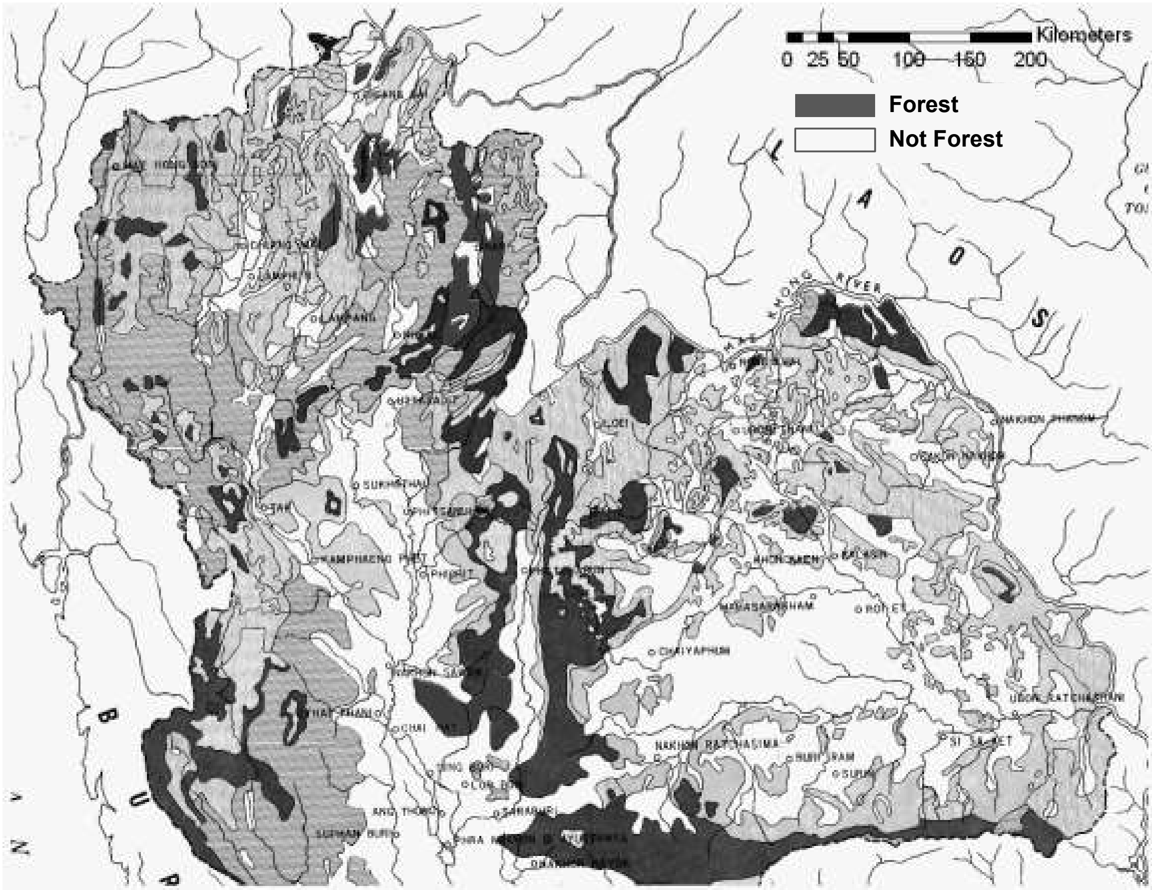
FIGURES AND TABLES

Figure 1: Sub-district and protected area boundaries (2000): North and NE Thailand



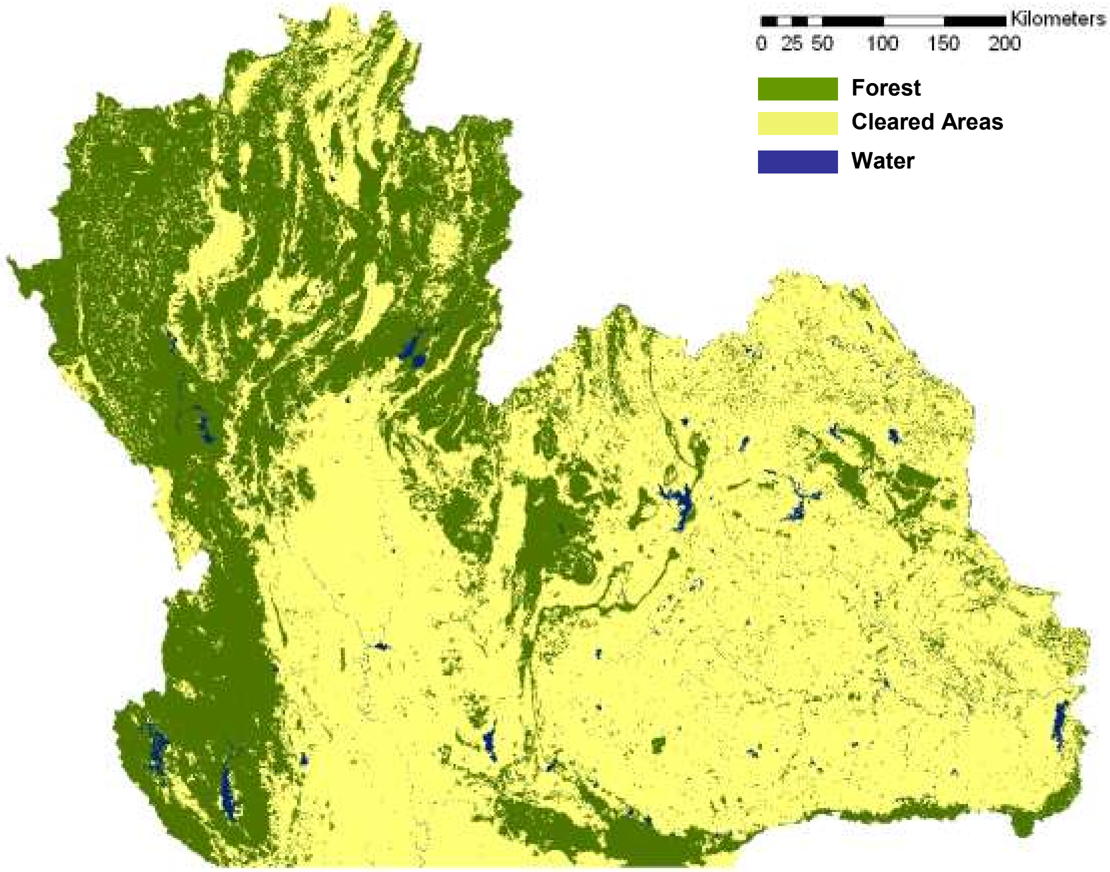
Source: IUCN Database of Protected Areas and Thai National Parks Division

Figure 2: Thailand: Forest cover circa 1967



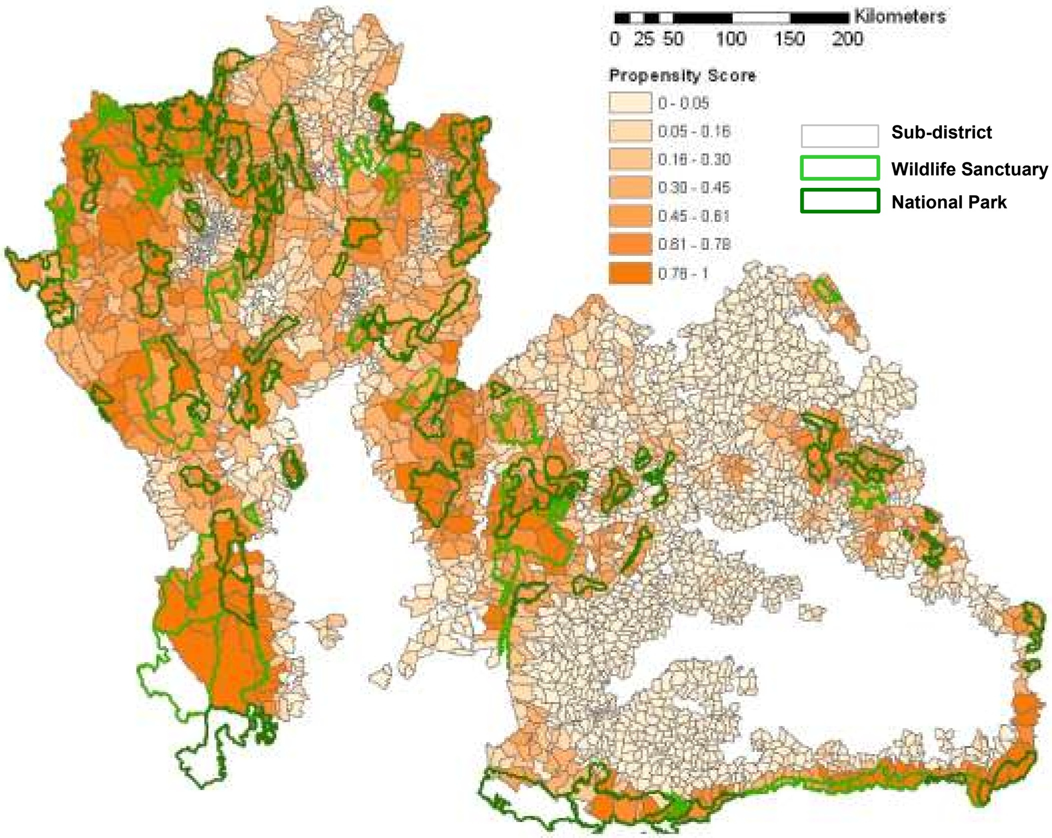
Source: Royal Forestry Department map, dated 1967 (Harvard Map Library, 1:2,500,000)

Figure 3: Forest cover in the year 2000



Source: Royal Forestry Department 2000 (courtesy of Marc Souris, IRD)

Figure 4: Propensity for protection (at sub-district level)



Propensity scores calculated as described in section 4. The map excludes sub-districts below 180 m elevation.

Table 1: Spatial database variables and summary statistics (full sample: N=4113)

Variable	Source	Mean	Min	Max
land in National Park (pct)	year 2000; IUCN World Database on Protected Areas (Thailand dataset supplied by ARCBC-ASEAN)	0.037	0.000	1.00
land in Wildlife Sanctuary (pct)		0.015	0.000	1.00
forest cover (pct)	year 2000, Royal Forest Department, based on Landsat 5 remote sensing. Data courtesy of Marc Souris (IRD)	0.171	0.000	0.988
avg per cap. consumption (Baht/mo)	Healy and Jitsuchon, forthcoming. Estimates are for the year 2000, relying on the Thai Population and Housing Census (2000), Socio-Economic Survey (2000), and Village Survey (1999)	1528	590	5453
estimated poverty headcount		0.214	0.000	0.957
estimated poverty gap		0.049	0.000	0.418
estimated squared poverty gap		0.017	0.000	0.209
estimated Gini coefficient		0.277	0.043	0.565
population density (people/ km^2)		107	0.321	3780
average slope (degrees)	NIMA's Digital Terrain Elevation Data GTOPO30/ USGS Global GIS (1999)	1.33	0.000	14.3
average elevation (degrees)		242	18.4	1400
maximum slope (degrees)		5.14	0.000	47.0
maximum elevation (m)		372	21.1	2435
distance to major city (km)	ESRI World Cities (2000) (population > 100,000)	86.7	2.74	241
distance to rail line (km)	Vector Map Level 0 / USGS Global GIS (1997)	57.1	0.015	222
distance to major river (km) (flow accumulation > 5000)	USGS EROS Data Center, Hydro 1k dataset	22.4	0.010	97.8
near boundary of major watershed		0.487	0.000	1.000
distance to mineral deposits (km)	Mineral Resource Data System (MRDS) / USGS Global GIS	116	0.771	376
distance to Thai border (km)	Vector Map Level 0 / USGS Global GIS (1997)	89.4	0.062	219
distance to major road, 1962 (km)	digitized East Asia Road Map, U.S. Map Service (1964); data from 1962	10.8	0.002	88.1
distance to any road, 1962 (km)		5.64	0.002	76.8
average monthly temperature (˚C)	Ministry of Transportation of Thailand / Marc Souris (IRD)	25.2	16.0	27.8
average monthly rainfall (mm)		1060	376	2310
forest cover, 1967 (percent)	digitized Royal Forestry Department map dated 1967	0.518	0.000	1.00
forest cover, 1973 (percent)	Tropical Rain Forest Information Center / NASA Landsat Multi Spectral Scanner (MSS)	0.233	0.000	1.00
forest cover, 1985 (percent)				
forest cover, 1992 (percent)		0.153	0.000	1.00
ecoregion 2 (percent tropical and sub-tropical coniferous forest)	WWF Conservation Science Program / USGS Global GIS	0.004	0.000	1.00
ecoregion 3 (percent tropical and sub-tropical dry broadleaf forest)		0.714	0.000	1.00
distance to major tributary (km)	Digitized from topographical maps and PSIG data / Marc Souris (IRD)	7.800	0.002	38.8
northeast region (dummy)	Thai NSO classification	0.638	0.000	1.000
land in Forest Reserves (percent)	TEI Thailand on a Disc (1999)	0.250	0.000	1.000
park tourists (million/year)	National Park, Wildlife, and Plant Conservation Department (fiscal years 1998-2000)	0.020	0.000	3.016

Table 2: What predicts protection?

Dependent variable:	percent protected (national park or wildlife sanctuary)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
log avg. slope	0.107***									0.058***
	(0.005)									(0.015)
log avg. elevation	0.021***									-0.032*
	(0.003)									(0.020)
log max slope		0.040***								0.002
		(0.003)								(0.007)
log max elevation		0.048***								0.044**
		(0.005)								(0.020)
log dist. nav river			0.034***							0.009***
			(0.003)							(0.002)
pct. forest in 1973				0.235***						0.039***
				(0.011)						(0.014)
log dist maj. city					0.036***					-0.020***
					(0.003)					(0.003)
log maj road 1962						0.010***				0.011***
						(0.003)				(0.002)
log any road 1962						0.048***				0.002
						(0.004)				(0.003)
dist. Thai border							-0.028***			-0.002
							(0.003)			(0.004)
near watershed boundary								0.069***		0.020***
								(0.005)		(0.004)
log dist. railroad									0.029***	-0.005***
									(0.002)	(0.002)
log dist. mineral										0.036***
										(0.003)
avg. temperature										-0.021***
										(0.005)
avg. rainfall										-0.000
										(0.000)
pct. ecoregion 2										-0.079
										(0.081)
pct. ecoregion 3										-0.043***
										(0.006)
adjusted R^2	0.308	0.277	0.038	0.248	0.022	0.077	0.024	0.045	0.038	0.364
N	4113	4113	4113	4113	4113	4113	4113	4113	4113	4113

*** p < .01 ** p< .05 * p< .10. Robust standard errors are in parentheses.

Table 3: Consumption / poverty headcount ratio and protected areas

Dependent variable:	**log mean consumption**				
	(1) No controls	(2) Province F.E. only	(3) Slope/Elev controls	(4) Geog. controls	(5) Full controls
National Park (pct)	-0.191***	-0.170***	0.061	0.133***	0.133***
	(0.044)	(0.045)	(0.040)	(0.037)	(0.037)
Wildlife Sanctuary (pct)	-0.278***	-0.217***	-0.000	0.098*	0.106*
	(0.069)	(0.075)	(0.055)	(0.055)	(0.055)
northeast dummy	yes	yes	yes	yes	yes
province fixed effects	no	yes	yes	yes	yes
slope and elevation controls	no	no	yes	yes	yes
geographic controls	no	no	no	yes	yes
historical forest cover	no	no	no	no	yes
Adjusted R2	0.143	0.417	0.466	0.570	0.574
N	4113	4113	4113	4113	4113

Dependent variable:	**log poverty headcount ratio**				
	(6) No controls	(7) Province F.E. only	(8) Slope/Elev controls	(9) Geog. controls	(10) Full controls
National Park (pct)	0.576***	0.458***	-0.110	-0.251***	-0.251***
	(0.125)	(0.099)	(0.067)	(0.061)	(0.062)
Wildlife Sanctuary (pct)	1.006***	0.595***	0.057	-0.124	-0.142
	(0.232)	(0.168)	(0.129)	(0.129)	(0.128)
northeast dummy	yes	yes	yes	yes	yes
province fixed effects	no	yes	yes	yes	yes
slope and elevation controls	no	no	yes	yes	yes
geographic controls	no	no	no	yes	yes
historical forest cover	no	no	no	no	yes
Adjusted R2	0.265	0.616	0.655	0.709	0.711
N	4113	4113	4113	4113	4113

*** $p < .01$ ** $p < .05$ * $p < .10$. Standard errors are robust, clustered at the district level
Slope and elevation controls = (log of) average slope, average elevation. Geographic controls = (log of) distance to major city, distance to rail line, distance to mineral deposits, distance to any roads (1962), distance to major roads (1962), max elevation, max slope, distance to national boundary, distance to navigable river; average temperature, average rainfall, ecoregion 2, ecoregion 3, near watershed. Historical forest cover = forest cover in 1973.

Table 4: Additional socio-economic outcomes and protected areas

Dependent variable:	**log poverty gap**		**log squared poverty gap**	
	(1) Province F.E. only	(2) Full controls	(3) Province F.E. only	(4) Full controls
National Park (pct)	0.359***	-0.245***	0.246***	-0.185***
	(0.093)	(0.061)	(0.078)	(0.053)
Wildlife Sanctuary (pct)	0.528***	-0.112	0.390**	-0.073
	(0.167)	(0.125)	(0.150)	(0.117)
northeast dummy	yes	yes	yes	yes
province fixed effects	yes	yes	yes	yes
slope and elevation controls	no	yes	no	yes
geographic controls	no	yes	no	yes
historical forest cover	no	yes	no	yes
Adjusted R2	0.609	0.684	0.586	0.644
N	4113	4113	4113	4113

Dependent variable:	**log gini coefficient**		**population density**	
	(5) Province F.E. only	(6) Full controls	(7) Province F.E. only	(8) Full controls
National Park (pct)	0.007	0.060*	-170.556***	15.953
	(0.022)	(0.033)	(33.007)	(15.045)
Wildlife Sanctuary (pct)	-0.023	0.040	-139.317***	33.692**
	(0.046)	(0.051)	(30.673)	(15.786)
northeast dummy	yes	yes	yes	yes
province fixed effects	yes	yes	yes	yes
slope and elevation controls	no	yes	no	yes
geographic controls	no	yes	no	yes
historical forest cover	no	yes	no	yes
Adjusted R2	0.455	0.477	0.140	0.346
N	4113	4113	4113	4113

*** p < .01 ** p< .05 * p< .10. Standard errors are robust, clustered at the district level
Slope and elevation controls = (log of) average slope, average elevation. Geographic controls = (log of) distance to major city, distance to rail line, distance to mineral deposits, distance to any roads (1962), distance to major roads (1962), max elevation, max slope, distance to national boundary, distance to navigable river; average temperature, average rainfall, ecoregion 2, ecoregion 3, near watershed. Historical forest cover = forest cover in 1973.

Table 5: Forest cover and protected areas

Dependent variable:	**forest cover, 2000 (percent)**				
	(1) No controls	(2) Province F.E. only	(3) Slope/Elev controls	(4) Geog. controls	(5) Full controls
National Park (pct)	0.805***	0.667***	0.197***	0.171***	0.171***
	(0.047)	(0.043)	(0.047)	(0.048)	(0.042)
Wildlife Sanctuary (pct)	0.857***	0.681***	0.262***	0.233***	0.215***
	(0.054)	(0.099)	(0.062)	(0.062)	(0.052)
northeast dummy	yes	yes	yes	yes	yes
province fixed effects	no	yes	yes	yes	yes
slope and elevation controls	no	no	yes	yes	yes
geographic controls	no	no	no	yes	yes
historical forest cover	no	no	no	no	yes
adjusted R^2	0.452	0.636	0.835	0.845	0.866
N	4113	4113	4113	4113	4113

Dependent variable:	**forest cover, by year (percent)**				
	(6) OLS (2000)	(7) Sub-district FE	(8) First Diffs	(9) Random Effects	(10) Sub-district FE w/ C.S.
National Park (pct)	0.101**	0.115***	0.082	0.121***	0.122***
	(0.050)	(0.039)	(0.063)	(0.038)	(0.043)
Wildlife Sanctuary (pct)	0.114	0.143***	0.174**	0.130**	0.142***
	(0.094)	(0.051)	(0.066)	(0.052)	(0.052)
province fixed effects	yes	--	--	--	--
geographic controls	yes	no	no	yes	no
sub-district fixed effects	no	yes	no	yes	yes
period fixed effects	no	yes	yes	yes	yes
adjusted R^2	0.768	0.351	0.132	--	0.316
N	1386	5473	4089	5473	3677

*** p < .01 ** p< .05 * p< .10. All standard errors are robust, clustered at the district level
Columns 1-5 show OLS regressions on the full sample. Slope and elevation controls = (log of) average slope, average elevation. Geographic controls = (log of) distance to major city, distance to rail line, distance to mineral deposits, distance to any roads (1962), distance to major roads (1962), max elevation, max slope, distance to national boundary, distance to navigable river; average temperature, average rainfall, ecoregion 2, ecoregion 3, near watershed. Historical forest cover = forest cover in 1973.
Columns 6-7 use the panel approach and limit observations to those with more than 10% of forest cover in 1973, less than 20% cloud cover and less than 20% land area in water. Column 6 repeats the OLS cross-section specification in Column 5 on this sub-sample; Column 7 includes sub-district and period fixed effects; Column 8 regresses changes in forest cover on changes in percent protected; Column 9 uses random effects estimation including the same additional fixed covariates as Column 5; and Column 10 repeats the specification of column 7 for the sample with common support (propensity score between .01 and 0.7).

Table 6: Sub-districts by likelihood of protection and land protected

	Land in NP or WLS (percent)			
propensity score (estimated)	0-5 %	5-20%	20-50%	50-100%
0-.05	1,621	32	17	2
.05-1	174	28	35	7
.1-.2	170	34	61	21
.2-.3	70	15	43	46
.3-.4	30	16	19	32
.4-.5	12	6	21	38
.5-.6	5	0	7	19
.6-.7	2	1	2	14
.7-1	0	0	0	7

Table 7: Estimates based on propensity score blocking

Dependent variable:	**forest cover (pct)**	**ln cons.**	**ln pov. headcnt.**	**ln poverty gap**	**ln sq. pov. gap**	**ln Gini coef.**	**pop. density**
1) Regular OLS on sample with high common support: propensity scores between 0.05-0.7							
NP (pct)	0.134***	0.137***	-0.280***	-0.294***	-0.233***	0.049	-7.749
	(0.042)	(0.038)	(0.062)	(0.060)	(0.049)	(0.043)	(5.824)
WLS (pct)	0.172***	0.120**	-0.175	-0.166	-0.126	0.071*	-5.253
	(0.050)	(0.047)	(0.120)	(0.122)	(0.117)	(0.036)	(5.610)
northeast dummy	yes	yes	yes	yes	yes	yes	yes
province FE	yes	yes	yes	yes	yes	yes	yes
slope/ elev controls	yes	yes	yes	yes	yes	yes	yes
geographic controls	yes	yes	yes	yes	yes	yes	yes
hist. forest cover	yes	yes	yes	yes	yes	yes	yes
N	928	928	928	928	928	928	928
2) Comparing within province and within propensity score group (propensity scores between 0.05-0.7							
NP (pct)	0.134***	0.117*	-0.218**	-0.234**	-0.190***	0.047	-6.808
	(0.044)	(0.059)	(0.101)	(0.092)	(0.070)	(0.048)	(7.272)
WLS (pct)	0.191***	0.047	-0.018	-0.015	-0.013	0.050	-10.728*
	(0.052)	(0.046)	(0.113)	(0.117)	(0.107)	(0.031)	(5.813)
prop. score FE	yes	yes	yes	yes	yes	yes	yes
province FE	yes	yes	yes	yes	yes	yes	yes
hist. forest cover	yes	yes	yes	yes	yes	yes	yes
N	928	928	928	928	928	928	928
3) Comparing within province and within propensity score group (propensity scores between 0.1-0.5							
NP (pct)	0.125***	0.112*	-0.191*	-0.189*	-0.138	0.063	-5.822
	(0.045)	(0.064)	(0.113)	(0.110)	(0.087)	(0.059)	(7.215)
WLS (pct)	0.198***	0.076	-0.068	-0.096	-0.108	0.052	-9.808
	(0.057)	(0.075)	(0.151)	(0.166)	(0.158)	(0.048)	(7.459)
prop. score FE	yes	yes	yes	yes	yes	yes	yes
province FE	yes	yes	yes	yes	yes	yes	yes
hist. forest cover	yes	yes	yes	yes	yes	yes	yes
N	634	634	634	634	634	634	634

*** p < .01 ** p< .05 * p< .10 Standard errors are robust, clustered at the district level
Slope and elevation controls = (log of) average slope, average elevation. Geographic controls = (log of) distance to major city, distance to rail line, distance to mineral deposits, distance to any roads (1962), distance to major roads (1962), max elevation, max slope, distance to national boundary, distance to navigable river; average temperature, average rainfall, ecoregion 2, ecoregion 3, near watershed. Historical forest cover = forest cover in 1973.

Table 8: Visitors statistics and regression estimates§

	Total National Park visitors fiscal years 1998-2000		
Region	**1998**	**1999**	**2000**
North	7,051,601	7,378,144	8,217,847
Northeast	3,422,564	2,984,041	2,601,519
Total	10,474,165	10,362,185	10,819,366

	Regression estimates including NP tourists			
Dependent variable:	**ln consumption**	**ln poverty headcount**	**ln Gini coef.**	**population density**
NP tourists (mil/yr)	0.071***	-0.042	0.032***	7.586
	(0.016)	(0.026)	(0.010)	(12.146)
NP (pct)	0.110***	-0.238***	0.050	13.535
	(0.036)	(0.062)	(0.032)	(13.610)
WLS (pct)	0.108*	-0.143	0.041	33.906**
	(0.055)	(0.128)	(0.051)	(15.992)
northeast dummy	yes	yes	yes	yes
province fixed effects	yes	yes	yes	yes
slope/ elev controls	yes	yes	yes	yes
geographic controls	yes	yes	yes	yes
historical forest cover	yes	yes	yes	yes
N	4113	4113	4113	4113

§ Visitor statistics from the National Park, Wildlife, and Plant Conservation Department Statistics.
Data courtesty of Nipaphorn Paisarn and Surachet Chettamart, Faculty of Forestry, Kasetsart University, Bangkok.
National Park tourists = millions of tourists/ year to first and second largest parks in sub-district. This includes foreign and domestic tourists.
Foreign tourists are approximately 10-15 percent of the total (Chettamart, pers comm).
*** $p < .01$ ** $p < .05$ * $p < .10$ Standard errors are robust, clustered at the district level
Slope and elevation controls = (log of) average slope, average elevation. Geographic controls = (log of) distance to major city, distance to rail line, distance to mineral deposits, distance to any roads (1962), distance to major roads (1962), max elevation, max slope, distance to national boundary, distance to navigable river; average temperature, average rainfall, ecoregion 2, ecoregion 3, near watershed. Historical forest cover = forest cover in 1973.
Note: The significance of the NP tourists variable is not robust to dropping sub-districts around the three parks that each receive more than 2 million visitors per year (Khao Yai, Doi Suthep-Pui, and Doi Inthanon). However, the signs are the same.