Tropical countries may be willing to pay more to protect their forests

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Inadequate funding from developed countries has hampered international efforts to conserve biodiversity in tropical forests. We present two complementary research approaches that reveal a significant increase in public demand for conservation within tropical developing countries as those countries reach upper-middle-income (UMI) status. We highlight UMI tropical countries because they contain nearly four-fifths of tropical primary forests, which are rich in biodiversity and stored carbon. The first approach is a set of statistical analyses of various cross-country conservation indicators, which suggests that protective government policies have lagged behind the increase in public demand in these countries. The second approach is a case study from Malaysia, which reveals in a more integrated fashion the linkages from rising household income to increased household willingness to pay for conservation, nongovernmental organization activity, and delayed government action. Our findings suggest that domestic funding in UMI tropical countries can play a larger role in (*i*) closing the funding gap for tropical forest conservation, and (*ii*) paying for supplementary conservation actions linked to international payments for reduced greenhouse gas emissions from deforestation and forest degradation in tropical countries.

protected area | valuation | choice experiment | REDD

Primary forests—"forests of native species in which there are no clearly visible signs of past or present human activity" (ref. 1, p. 11)—are globally significant repositories of biodiversity (2) and carbon (3). The global area of these forests is declining at an annual percentage rate that is nearly triple the rate for total global forest area (ref. 1, tables 2.4 and 3.3). Virtually all of the loss is occurring in tropical countries (*SI Text*, section 1). Logging is the main cause of the loss (ref. 1, p. 27), but hunting threatens biodiversity even in primary forests with intact tree cover (4, 5).

Protecting primary tropical forests is a core mission of several international institutions created since the early 1990s, including the Convention on Biological Diversity (CBD), the Global Environment Facility (GEF), and the UN Collaborative Program on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD). However, the CBD failed to achieve its goal of significantly reducing biodiversity loss by 2010 (6); international funding for biodiversity protection through the GEF and other mechanisms is below commitments made at the 1992 Earth Summit (7) and the amounts required to achieve the CBD's 2020 protection targets (8); and REDD has not advanced beyond a readiness phase (www.un-redd.org). Relying on international mechanisms to fund protection of primary tropical forests does not look like a winning strategy.

Here, we argue that economic development during the past 20–25 y has raised public demand for forest protection within tropical countries, but the level of protection supplied by tropical country governments has not kept pace. We focus on the dynamics of conservation and development within relatively wealthier developing countries: The group that is classified by the World Bank as upper-middle income (UMI). As we will show, the majority of primary forest area in tropical countries is found in these countries. We hypothesize that public willingness to pay (WTP) to protect forests has reached a relatively high level in UMI countries, leading to greater support for local conservation nongovernmental organizations (NGOs) and prompting governments to boost forest protection efforts—but not as much as the public would like. This gap between domestic demand and domestic supply of forest protection has two important implications: Domestic funding might be sufficient to cover the costs of additional protection in some, and perhaps many, tropical countries; and international funding might be able to leverage more domestic funding than it currently does.

Although many cross-country studies in the environmental Kuznets curve (EKC) literature have investigated the effect of rising national income on deforestation (9), none has considered the effect on primary forests. This gap matters because deforestation, unlike primary forest loss, results mainly from agricultural conversion, not logging (1, 10). A few cross-country studies have considered the effect of national income on creation of protected areas (11–16), but with mixed findings on the significance of the effect. A second and larger group of studies has used surveys to measure WTP for biodiversity conservation by domestic populations within particular countries. Most of these studies have failed to detect a significant income effect ($P < 0.05$) (17, 18). Metaanalyses of these studies estimate income effects that are generally positive (protection increases with income) but not necessarily statistically significant (17, 18).

We extended this prior work by coupling two research approaches: a broad-brush statistical analysis of the association between a standard measure of economic development, i.e.,

Significance

Tropical forests, especially the primary tropical forests that are globally important for biodiversity conservation and carbon storage, are increasingly concentrated in relatively wealthier developing countries. This creates an opportunity for domestic funding by these countries to play a larger role in (*i*) closing the funding gap for tropical forest conservation, and (*ii*) paying for supplementary conservation actions linked to international payments for reduced greenhouse gas emissions from deforestation and forest degradation.

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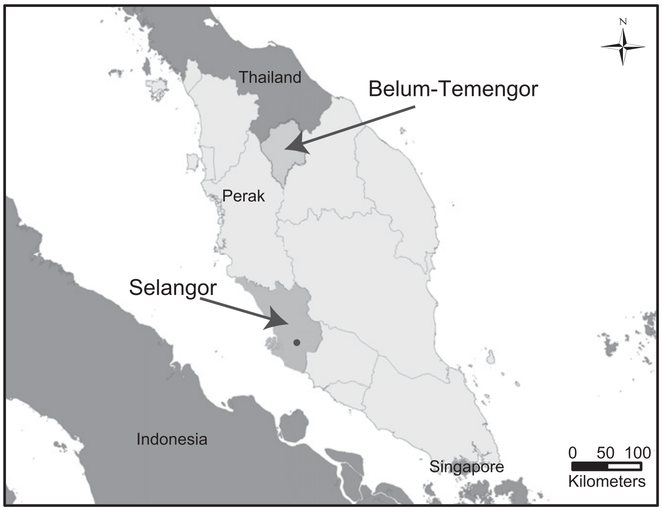

Fig. 1. Locations of Belum–Temengor (site of forest protection plans in choice experiments) and Selangor and Kuala Lumpur (site of household survey; the black dot is Kuala Lumpur) within Peninsular Malaysia (light gray). Lines show Malaysian state boundaries. Sources: base map, GADM database (www.gadm.org); Belum–Temengor boundaries, Forest Research Institute Malaysia.

per capita gross national income (GNI), and a large set of cross-country conservation indicators (CIs); and a focused investigation of forest protection in a particular UMI country, Malaysia. The statistical analysis spanned 12 indicators from 10 diverse sources (*Materials and Methods* and *SI Text*, section 1). The indicators pertained to public environmental preferences, conservation NGOs, and government action (conservation spending, protected area establishment). These indicators relate more directly to our hypothesis about domestic demand and domestic supply of forest protection than do the deforestation rates analyzed by EKC studies. We limited the samples to countries classified as tropical by the UN Food and Agriculture Organization Forestry Department (ref. 19, data table 2) and paid special attention to differences between tropical countries in the UMI group and ones in lower income groups.

The Malaysian case study allowed us to examine more closely the linkages from rising household income to increased household WTP, NGO engagement, and government protective action, and thereby uncover reasons for the underprovision of forest protection relative to household preferences. The case concerned Belum–Temengor, a 300,000-ha forested region in the state of Perak (Fig. 1). This region contains the largest area of primary forest in Peninsular Malaysia outside a national park. Our research included a population-representative survey of 1,261 rural and urban households in the Malaysian state of Selangor and the federal territory of Kuala Lumpur during 2010 (*Materials and Methods*). We used choice experiments (20, 21) to estimate household WTP to protect Belum–Temengor against logging and poaching (*SI Text*, section 2). Information from the case study enabled us to compare the public's aggregate WTP for protection to current protection expenditures and to discuss why there is a gap between the two.

Results

Forests in UMI Tropical Countries. By 2010, nearly half of the global area of forests in tropical countries was in 27 countries classified by the World Bank as UMI (*SI Text*, section 1). These countries included Brazil, Costa Rica, Gabon, Malaysia, Mexico, Peru, and Thailand. The UMI group is expanding: Only 9 of the 27 countries were in it in 1990, and 9 additional tropical countries will join it within 25 y (and 10 more within 50 y) if 1995–2012 income growth rates continue (*SI Text*, section 1). UMI countries also contained a disproportionate share of the 2010 global area of primary forest in tropical countries (Fig. 2). They contained nearly half of the threatened endemic mammal, bird, and plant species found in tropical countries (Fig. 2) and ranked highly according to several other biodiversity indicators (*SI Text*, section 1), including megadiversity (22), irreplaceable protected areas (23), the GEF benefits index (24), and the mammal global biodiversity fraction (25).

Cross-Country Evidence on Conservation in Tropical Countries. The most empirically compelling approach for statistically identifying associations between CIs and economic development involves analyzing changes within countries over time, by using fixed-effects regression models to control for unobserved country characteristics that could confound the observed associations. This approach requires data that vary not only cross-sectionally but also longitudinally. We compiled such data for six indicators (Table 1). We first tested the difference between an indicator's mean when countries were in the low- or lower-middle-income group and its mean when the countries were in the UMI group (central columns in Table 1). We found consistent evidence that reaching the UMI group was associated with higher public support for environmental protection (the first two indicators), larger donations to domestic conservation NGOs (the third indicator), and a stronger government response as measured by cofinancing of GEF forest biodiversity projects (the fourth indicator) and creating protected areas (the last two indicators).

To illustrate, consider the first indicator. The results indicate that, on average, the share of households that favored protecting the environment over economic growth and job creation was 0.116 higher when countries were in the UMI group than in the lower-middle-income group and 0.276 higher when they were in the UMI group than in the low-income group. Similarly, when countries were in the UMI group instead of one of the lower income groups, higher shares of households identified the environment as the most serious problem confronting their countries, domestic donations to the countries' World Wide Fund for Nature (WWF) chapters were higher, cofinancing accounted for

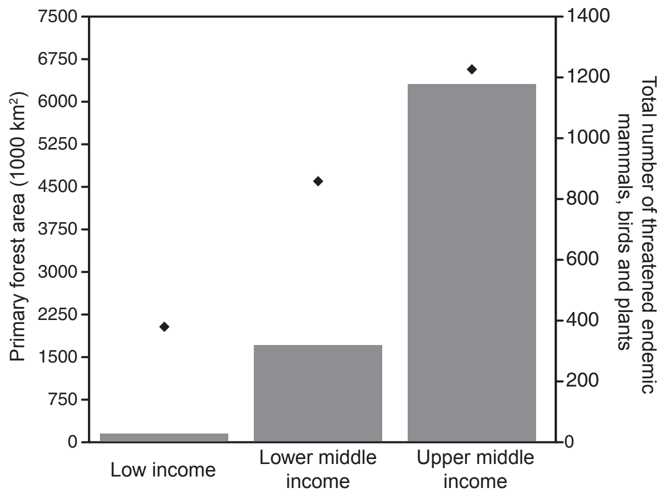

Fig. 2. Aggregate primary forest area (bars, left axis) and number of threatened endemic mammal, bird, and plant species (diamonds, right axis) in tropical countries, by World Bank income group. Area estimates and income classification are for 2010, whereas species estimates are for 2013. Estimates are not shown for high-income tropical countries, which account for very small shares of both variables. See *SI Text*, section 1 for data sources.

Table 1. Association of economic development with cross-country CIs that have data for multiple years

Variable	Source	Mean for indicated income group minus mean for UMI group			Per capita GNI	
		n	Low income	Lower-middle income	*n*	Elasticity
Public opinion						
1 = protecting the environment should be given priority, 0 = economic growth and creating jobs should be the top priority	World Values Survey	54,058 household years	−0.276 (0.000)	−0.116 (0.008)	50,815 household years	0.745 (0.000)
1 = environment is the most serious problem facing the country, 0 = other problems are more serious	AmericasBarometer	113,226 household years	−0.00797 (0.031)	−0.00511 (0.148)	101,039 household years	5.32 (0.005)
Domestic donations to WWF (constant 2005 US dollars per thousand people)	WWF country chapters	42 country years	−1.03 (0.084)	−0.772 (0.174)	42 country years	5.64 (0.001)
% cofinancing of GEF forest biodiversity projects	GEF	369 projects	−24.7 (0.002)	−12.0 (0.008)	324 projects	0.655 (0.002)
% land area in terrestrial protected areas	World Bank	2,285 country years	−3.18 (0.000)	−1.94 (0.009)	1,416 country years	0.311 (0.001)
% land area in forests protected for biodiversity conservation	UN Food and Agriculture Organization	361 country years	−0.758 (0.080)	−0.418 (0.260)	254 country years	0.189 (0.072)

For each indicator, results are shown for two regression models that included country fixed effects. Results for the first model (three center columns) give the difference between an indicator's mean when countries were in the low- or lower-middle-income group and its mean when countries were in the UMI group. Negative values indicate that the mean was higher when countries were in the UMI group. Results for the second model (last two columns) show the association between an indicator and per capita GNI, as a continuous measure of development level that is more precise than income group. A positive elasticity of value *x* indicates that, on average, a 1% change in per capita GNI over time in a country was associated with an *x*% increase in the indicator. *P* values for two-sided *t* tests of differences from zero are shown in parentheses next to the estimates. Samples included only tropical countries (ref. 19, data table 2). See *Materials and Methods*; *SI Text*, section 1; and Table S1 for additional details.

larger percentages of the budgets of GEF forest biodiversity projects, and protected areas and forests protected for biodiversity conservation covered larger percentages of national land area. Not surprisingly, differences were larger and more highly significant between the UMI group and the low-income group than between the UMI group and the lower-middle-income group.

We then tested the association between each indicator and country-level per capita GNI, as a continuous measure of development level that is more precise than income group. Table 1 presents these associations as elasticities: the percentage change in an indicator for a 1% increase in per capita GNI. All of the elasticities were positive, with significance levels ranging from $P < 0.001$ to $P = 0.072$. This positive effect is consistent with the income-group results. The unitless nature of elasticities enabled us to compare their relative sizes, and this comparison supports our hypothesis that emerging household preferences for protection have not translated expeditiously into official action: The indicators of public opinion and NGO donations were more responsive to increases in income than the indicators of government action. Government action has been especially slow to respond to rising income in the case of forest protection for biodiversity conservation.

Data were available for a single time period for six other CIs: public concern about global loss of biodiversity, number of environmental NGOs per million people, and four indicators of domestic spending on conservation, protected areas, and forestry. Although these purely cross-sectional indicators do not allow the use of fixed effects to control for unobserved influences as in the case of the indicators in Table 1, they do allow us to consider whether the patterns in that table hold across a wider array of evidence. We found that they do (Table S2): The indicators were higher on average for the UMI group than for the lower income groups and were positively and significantly ($P < 0.05$) associated with per capita GNI.

Malaysian Case Study: Protecting Belum–Temengor Against Logging and Poaching. Compared with the cross-country analyses, the Malaysian case study provides more tightly integrated evidence of public demand for conservation rising with economic development, local NGOs playing a lead role in advocating stronger government action to protect forests, and the government response falling short of the NGOs' goal and the public's preferred protection level. This evidence indicates that public WTP for protection far exceeds public expenditures.

Malaysia reached the UMI level in 1992. Its initial growth after independence in 1957 was fueled by conversion of lowland rainforests to rubber and oil palm plantations (26). Belum–Temengor has been spared conversion due to its hilly terrain and moderate-to-high elevation. As early as 1968 (27), a report commissioned by the Malaysian federal government recommended establishing a wildlife reserve in Belum–Temengor to protect populations of the Asian elephant, Malayan tiger, Sumatran rhinoceros, and other large mammals.

Protecting Belum–Temengor against logging and poaching has been a priority of Malaysia's two leading conservation NGOs, the Malaysian Nature Society (MNS) and WWF Malaysia, since the early 1990s (28). The Malaysian constitution assigns jurisdiction over forests to state governments (26). MNS and WWF Malaysia have used a variety of approaches to convince the Perak state government to protect Belum–Temengor (28), including organizing scientific expeditions, enlisting the support of federal agencies and the Perak royal family, and partnering with local companies and celebrities on a postcard campaign that delivered the signatures of more than 80,000 individuals who supported protection to state and federal leaders.

These efforts achieved partial success in 2007, when the Perak state government established about one-third of Belum–Temengor as the Royal Belum State Park (28). The rest of the area remained open to logging, however, and by establishing the park under state law instead of the National Parks Act, the state government retained authority to reopen it for logging. Such excisions have occurred in other Malaysian states (29). Lack of national park status also reduces access to federal resources to combat poaching, which remains a serious problem (30).

The state government has been reluctant to protect Belum–Temengor more completely and more permanently against logging due to a concern over lost revenue and jobs (31). We conducted the household survey to determine if Malaysian households outside of Perak were satisfied with partial protection of Belum–Temengor or would prefer a higher level of protection, in the sense of being willing to pay an amount that would cover the opportunity costs to the state and the direct costs of protection against poaching. Because the policy issue was not simply whether to protect the forest, but how large an area to protect and against which threats—logging, poaching, or both—we designed the choice experiments to generate data for estimating households' WTP for different levels and types of protection (*SI Text*, section 2).

We depicted protection against poaching as providing a single benefit, reduced extinctions in Belum–Temengor, and protection against logging as providing two benefits, reduced extinctions in Belum–Temengor and reduced flooding in Perak (not in Selangor or Kuala Lumpur). We described poaching as affecting mainly large mammals; and logging as affecting mainly smaller mammals, reptiles, amphibians, and insects (*SI Text*, section 2).

We found that mean household WTP was significantly greater than zero for both types of protection (*SI Text*, section 2): expressed as monthly payments to protect 100,000 ha and with 99% confidence intervals in parentheses, US$1.08 (US$0.91–1.25) for logging and US$0.71 (US$0.62–0.80) for poaching. These amounts were equivalent to about 0.1% of mean monthly income for households in Selangor and Kuala Lumpur. Households were willing to pay a monthly premium of US$0.67 (US$0.57–0.76) for plans that supplied maximum protection (all 300,000 ha protected against both threats), over and above the sum of WTP for complete protection against the two threats calculated separately. Given the physical separation of Belum–Temengor from the surveyed locations and limited recreational access to Belum–Temengor as of 2010 (28), the households' WTP probably reflects mainly existence, option, and bequest values (32), although it might also reflect expectations about future recreational use.

We estimated societal WTP to protect all of Belum–Temengor against both logging and poaching by multiplying these mean estimates by the number of households in Kuala Lumpur and Selangor (Table 2). We compared this measure of societal benefits to the societal costs, which included opportunity costs and direct management costs (*SI Text*, section 3). We found that the societal benefits were nearly twice as large as the societal costs (Table 2). This likely understates the true benefit–cost ratio, because it ignores benefits to the more than 70% of Malaysian households that do not live in Kuala Lumpur or Selangor and because our cost assumptions were likely to be upwardly biased (*SI Text*, section 3).

Expressed per hectare, annual societal WTP to protect Belum–Temengor, US$437, is much larger than the annual operating budgets of the two largest existing protected areas in Peninsular Malaysia, US$12.80 at Endau–Rompin and only US$0.98 at Taman Negara (2005 estimates converted to 2010 price levels) (33). This comparison suggests that Malaysian protected areas are extremely underfunded, which is also indicated by comparisons of conservation spending in Malaysia to spending in other countries (25, 33). We caution, however, that Malaysian households' incremental WTP to protect other forests in addition to Belum–Temengor would likely be lower than their WTP to protect the latter (*SI Text*, section 4).

Table 2. Conservative estimates of aggregate annual benefits and costs to the populations of Kuala Lumpur and Selangor of fully protecting all of Belum–Temengor

Item	Value
Benefits, US$ million/y	
WTP to protect against logging	70.3
WTP to protect against poaching	46.3
WTP premium for maximum protection	14.5
Total	131.2
Costs, US$ million/y	
Direct	10.1
Opportunity: forgone timber revenue	51.2
Opportunity: WTP for job creation	6.4
Total	67.7
Benefits − costs	63.4
Benefit/cost ratio	1.9

Estimates are at 2010 price levels. Original estimates in Malaysian ringgit were converted to US dollars using the 2010 official exchange rate (which equaled 3.22 ringgit per dollar). Benefits were aggregated across households by multiplying mean estimates per household by the number of households (1,812,734) in Selangor and Kuala Lumpur in 2010 (48).

Our estimate of the societal benefits of protecting Belum–Temengor is probably understated from a long-run perspective because it ignores future income growth. Analysis of the household-level WTP estimates (*Materials and Methods*) revealed a significant and positive association with income for monthly household incomes above US$2,329 for both logging ($P = 0.035$) and poaching ($P = 0.029$) (Table S3), but no significant association for incomes below this level. At the mean household size in the sample, this monthly income threshold is equivalent to an annual per capita income of US$6,223. This is within the World Bank's UMI range and provides a microlevel complement to the macrolevel evidence in Table 1 that income at the UMI level is associated with a substantial increase in conservation demand.

On average, a 1% increase in income above this threshold was associated with 0.26% and 0.27% increases in WTP for protection against logging and poaching, respectively (Table S3). This less-than-proportional relationship mirrors results from metaanalyses of conservation valuation studies, which report estimates in the range of 0.38% (17) to 0.5–0.8% (18). A downward bias due to measurement error (our survey recorded household income as being within given ranges, not as exact values) might explain why our estimates are smaller than these. A positive effect of Malaysian economic development on WTP for conservation is also suggested by the trend in per capita donations to WWF Malaysia, which increased more than 10-fold in inflation-adjusted terms between 2002 and 2012 (*SI Text*, section 1).

Discussion

Our cross-country analyses and Malaysian case study provide evidence of a significant increase in public demand for conservation in relatively wealthier tropical countries, which has not been matched by protective actions by the countries' governments. This delayed government response likely has multiple explanations. One is imperfect information: Governments may simply not know what the public wants. Only one of the two recurrent cross-country public-opinion surveys in our cross-country analyses contained a question about biodiversity loss, and that question was added only recently and referred to global biodiversity loss, not loss in the countries surveyed (Table S2). Moreover, both surveys covered only a small minority of tropical countries. In Malaysia, survey-based information on public preferences for protecting Belum–Temengor did not exist before we conducted our survey. Providing policymakers with better information on public preferences is an important potential contribution of environmental valuation surveys in developing countries (34), but to our knowledge no prior forest valuation study in any tropical country had surveyed a representative sample of rural and urban households at either a national or state/provincial level (*SI Text*, section 1).

A second explanation is imperfect political processes, which compound the impact of imperfect information. Countries that are less democratic tend to protect less land (15). Among all countries in the world, the average UMI tropical country was only at the 57th percentile of a commonly used democracy indicator, the World Bank's voice and accountability index (*SI Text*, section 1). Mean ratings were even lower for less wealthy tropical countries, which suggests that the positive effect of economic development on government conservation actions revealed by the cross-country analyses could be due in part to improved political institutions and not just income growth per se. Malaysia's rating puts it at the 34th percentile, which is below the mean for even lower-middle income tropical countries. A relative lack of voice and accountability in this UMI country may help explain the slow and incomplete progress toward protecting Belum–Temengor.

The Malaysian case also suggests a third explanation: the classic political economy problem of concentrated costs (forgone logging revenue and jobs within Perak) coinciding with dispersed benefits (WTP for protection being spread across many households outside Perak) (35). This situation is not unique to tropical countries; for example, the United States' 1964 Wilderness Act launched decades of court battles between the timber industry and conservation groups over protection of national forests against logging before large areas were protected under the Act (36, 37). It probably has a greater impact on conservation outcomes in tropical countries, however, due to information on the benefits of conservation being less abundant and NGOs being more poorly funded in these countries.

Delayed conservation action by tropical country governments has policy implications for international funding of tropical forest protection. Controlling for other factors, developing countries receive less biodiversity aid as per capita national income rises (7). This could create a funding gap if, as a result of delayed action, domestic funding does not increase sufficiently rapidly to offset the decline in external funding. There is evidence that this has happened: Data from a recent study on underfunding of biodiversity conservation (25) show that spending in tropical countries fell short of expected levels by the greatest amounts in countries in the UMI group (*SI Text*, section 1). Malaysia is the seventh most underfunded country in the world according to that study (ref. 25, table 2).

The ranking of countries by degree of underfunding has been advocated as a guide for reallocating international conservation funding (25). Our findings suggest that increased domestic funding should also be emphasized in closing the funding gap, at least in UMI countries. A greater emphasis on domestic funding is also implied by a fourth possible explanation for delayed conservation action: Tropical country governments might be deliberately undersupplying domestic funding in a strategic attempt to attract increased external funding. This explanation comes from the general aid literature (38), and we know of no careful analysis of it for conservation aid.

The international community could facilitate increased domestic funding not only through the development of new funding mechanisms, such as payments for ecosystem services, but also by actions that address the factors that cause tropical country governments to lag behind their publics. Possible actions include funding the provision of better information on public preferences, supporting programs that aim to improve governance, strengthening local NGOs, and, to counter strategic underfunding by aid recipients (38), tying aid to specific projects implemented by donor country organizations and delegating aid responsibility to agencies whose primary mission is not conservation. Greater domestic funding resulting from these actions might have a positive feedback on international funding, as there is evidence that the public in donor countries favors recipient countries sharing the responsibility for tropical forest protection (39).

Our findings also have implications for international funding via REDD. Supplementary biodiversity payments have been proposed as a mechanism that would not only enhance biodiversity outcomes under REDD, but also achieve additional greenhouse gas emissions reductions (40). This proposal has been couched in terms of international funding for the biodiversity payments. Our findings provide an economic rationale for coupling international carbon payments made to UMI tropical countries under REDD with biodiversity payments funded by those countries themselves.

Materials and Methods

Analysis of Cross-Country CIs. To facilitate comparison across the CIs, we used identical regression specifications to model the indicators' association with income (*SI Text*, section 1). We tested mean differences between income groups by estimating

$$CI_{it} = c_i + \beta_{LI} LI_{it} + \beta_{LMI} LMI_{it} + \beta_{HI} HI_{it} + u_{it}.$$

LI_{it}, LMI_{it}, and HI_{it} are dummy variables indicating the income group (low, lower-middle, and high, respectively) for country i in year t. The number of countries and time periods depended on data availability for a given indicator (Tables S1 and S2). Because UMI is the omitted group, the regression coefficients (the βs) measure the mean difference in an indicator's level between these groups and the UMI group. c_i is a country fixed effect, which was included only for indicators with data for multiple time periods, and u_{it} is the error term. We used robust SEs (41, 42) clustered by country or country year, depending on data structure.

To test the significance of the association of an indicator with per capita GNI (PCGNI), which was measured in constant 2005 US dollars, we estimated

$$\ln(CI_{it}) = c_i + \beta_{PCGNI} \ln(PCGNI_{it}) + u_{it}.$$

Estimation procedures were otherwise identical to those for the income-group models. We interpreted the effect of PCGNI as a broad measure of various interrelated aspects of economic development, not a pure income effect; identifying the latter would require inclusion of additional controls. Although the correlation of PCGNI with other factors that tend to change with development therefore does not confound our interpretation of its effect, reverse causality could, but any resulting bias in the estimate of β_{PCGNI} is probably small (*SI Text*, section 1).

Household Survey. We followed a comprehensive survey development process aimed at addressing methodological problems that have often affected valuation studies in developing countries (43). Planning began in April 2007. During February 2008 to January 2010, we selected a Malaysian survey research firm through a competitive bidding process; designed the sampling plan in consultation with the Malaysian Department of Statistics; conducted 5 focus groups and 26 cognitive interviews, which generated drafts of the survey instrument; translated the instrument from English into Bahasa Malaysia, Mandarin, and Tamil, with reverse translation to check translation accuracy; and ran 3 pretests. We finalized the instrument and selected and trained enumerators during February to March 2010. We implemented the survey during April to June 2010. The survey was reviewed and approved by relevant committees within the Forest Research Institute Malaysia that function in a manner similar to an institutional review board, and informed consent was obtained from respondents.

We used a stratified two-stage sample design, with three strata: rural Selangor, urban Selangor, and Kuala Lumpur (entirely urban). We randomly selected 70 enumeration blocks (a Malaysian census unit) from each stratum in the first stage and 10 living quarters from each block in the second stage. The sample thus consisted of 2,100 living quarters. We successfully interviewed 1,261 households, for a 67% response rate after accounting for 210 living quarters that were either vacant or not occupied by Malaysian citizens.

Choice Experiments. Respondents were presented a series of four choice sets, each with three choice alternatives (forest management plans) (*SI Text*,

SUSTAINABILITY SCIENCE

section 2). One alternative in each set was the status quo. Each alternative had four attributes: area logged, area poached, jobs created, and cost. Each attribute had three levels: 0, 150,000, and 300,000 ha for the two area attributes (associated with none, half, and all of the corresponding threatened species going extinct); 2,500, 5,000, and 7,500 jobs created; and 2, 6, and 10 Malaysian ringgit per month for the cost attribute. The flood attribute was collinear with area logged (one, three, and five floods per year in Perak).

Analysis of Choice Experiment Responses. We fit a mixed logit model to the responses from the choice experiments (44, 45), with correlated random coefficients and SEs that were clustered by enumeration block (*SI Text*, section 2). The model included six explanatory variables: area protected against logging, area protected against poaching, jobs created, a dummy variable for the status quo alternative, a dummy variable for plans that supplied maximum protection (all 300,000 ha protected against both logging and poaching), and the cost of the plan (Tables S4 and S5). All coefficients were distributed normally except the coefficient on the cost of a plan, which was distributed log-normally (ref. 46, p. 611).

We used results from the mixed logit model to predict WTP for each respondent. We calculated individual-level parameters for the variables in the model using 250 Halton draws (47). Once these parameters were calculated, we calculated WTP by dividing a respondent's parameter for a given attribute of a plan by the respondent's parameter for the cost of the plan. The means and confidence intervals reported in the text were calculated with household size and ethnicity used as poststratification weights.

Analysis of Household WTP. We used multiple regression (ordinary least-squares with poststratification weights) to investigate the effects of socioeconomic variables on household WTP for protection against logging and poaching (*SI Text*, section 2). The variables were gross household income and household size; age, education, and ethnicity of the household head; and stratum. Coefficients on dummy variables for income categories indicated a threshold for the income effect between the fifth and sixth categories, so we reestimated the models using an income spline, with a knot at that point (Table S3).

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