LETTER

Does Indonesia's REDD+ moratorium on new concessions spare imminently threatened forests?

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Abstract

In May 2010, Indonesia signed a $1-billion partnership with Norway to reduce deforestation and prepare for a global REDD+ scheme (Reducing Emissions from Deforestation and forest Degradation). A pillar of the pact is a moratorium on new agricultural and logging licenses in ~535,294 km^2 of species-rich dryland forest and ~153,984 km^2 of carbon-rich peatlands. A critical question is whether these moratorium areas constitute "additional" conservation. We test whether dryland forests and peatlands within moratorium areas differ from unprotected forest and recently cleared forest on a range of biophysical, economic, and agricultural attributes indicative of forest threat. Compared to other forests, dryland moratorium forests are significantly more marginal economically, less physically accessible, more removed from forest disruption, and more sheltered from encroachment, such that their "conservation" achieves little additional prevention of forest loss and carbon emissions. Peatland moratorium areas are, however, a conservation success insofar as they are indistinguishable from unprotected peatland and encompass the majority of remaining peatland area, much of which is vulnerable to future conversion.

Introduction

Indonesiais the world's third largest emitter of greenhouse gases, largely because of the widespread felling and burning of its rainforests and carbon-rich peat-swamp forests (PEACE 2007; Miettinen *et al.* 2011). In an effort to slow forest disruption and resulting greenhouse gas emissions, Indonesia and Norway signed a landmark pact in May 2010, hereafter termed the "Partnership" (Solheim and Natalegawa 2010). This Partnership will pay Indonesia up to U.S.$1 billion for advancing forest-emission reduction initiatives over 2 years. Most of this $1 billion will be paid upon the implementation of a provincial pilot program yielding verified reductions in forest-carbon emissions, whereas a key longer term goal is to ready Indonesia to benefit from international carbon markets (Solheim and Natalegawa 2010; Edwards *et al.* 2011a).

With the release of Presidential Instruction No. 10/2011 on 20 May 2011 (Yudhoyono 2011a), Indonesian President Yudhoyono has indicated how the country plans to protect its forests. This Instruction outlines a moratorium on new logging or agricultural concessions (including oil-palm and paper-pulp tree plantations) in primary dryland forests and peatlands. In July 2011, it was accompanied by 291 maps outlining the specific forests protected under the moratorium (Ministry of Forestry 2011a). These "moratorium forests" have been set aside with a view to drawing funding from the Partnership in the short term. Over the longer term, the moratorium aims to support Indonesia's goal of reducing national emissions by 26% by 2020, and to prepare Indonesia to draw payments from industrial nations via the Reducing Emissions from Deforestation and Forest Degradation (REDD+) scheme.

REDD+ payments are intended to safeguard threatened tropical forests by providing economic incentives for continued forest integrity (Venter & Koh 2011). To merit such payments, newly protected forest should encompass imminently threatened areas or otherwise serve to reduce overall rates of forest emissions over relatively short periods. Moratorium reserves that are relatively unthreatened would not satisfy such criteria, as their conservation would entail little "additionality," that is, additional prevention of deforestation and carbon emissions. To date, there has been limited empirical analysis of whether Indonesia's moratorium forests are likely to constitute "additional" conservation and reductions in deforestation (Murdiyarso *et al.* 2011; Saxon & Sheppard 2011; Austin *et al.* 2012). This is a critical knowledge gap: if Indonesia is to reap the benefits of the Partnership and reduce its forest emissions, then its moratorium-forest reserves should prevent imminent forest destruction. Powerful interests in Indonesia, most notably the oil-palm, timber, and wood-pulp industries, are opposing a carbon-market future and lobbying to exclude threatened forests from the moratorium (Edwards *et al.* 2011a). If they succeed, Indonesia's embryonic carbon market could suffer a severe or even fatal blow.

To address the issue of additionality we compared the moratorium-forest reserves to unprotected forest and recently cleared forest on a range of attributes describing threats to forest integrity. We did so for peatland and dryland rainforests separately, as these forest types differ greatly in their carbon densities and rate of deforestation (Miettinen *et al.* 2011; Page *et al.* 2011). In this way, we assess whether forests protected under the Instruction are relatively threatened.

Methods

Our methods entailed four steps. First, we mapped Indonesia's moratorium forests, non-moratorium forests, and recently cleared forest classes for dryland and peatland forest types. Second, we defined various spatially explicit agricultural, economic, and biophysical attributes by which to compare these forest classes. Third, we overlaid a grid of 1-km^2 cells on the study extent, recorded the forest class and attribute values for each cell, and sampled a subset for analysis. Fourth, we conducted multivariate analyses to compare the forest classes for differences on the attributes.

Forest-cover definitions and mapping

We defined three forest classes within dryland and peatland forests (Table S1).

Moratorium forest

Dryland moratorium areas largely contain "primary" (i.e., unexploited) mixed-dipterocarp and other hardwood rainforests, as per a 2009 Landsat satellite-image analysis by the Indonesian Ministry of Forestry, hereafter "MoF" (Ministry of Forestry 2011b; Wells & Paoli 2011a). Peatland moratorium areas are largely based on the >50-cm peat-depth class mapped by Wetlands International, hereafter "WI" (Wahyunto & Subagjo 2003, 2004, 2006; Wayunto & Suryadiputra 2008; Wells & Paoli 2011a, 2011b). Moratorium areas exclude logging and agricultural concessions (Yudhoyono 2011a).

Our base map of the dryland moratorium forest and the peatland moratorium forest classes is a digital map from Indonesia's Presidential Office, hereafter "IPO" (Presidential Working Unit 2011). This map does not differentiate between dryland and peatland moratorium areas, unlike the otherwise equivalent 291 map sheets released by the MoF at 1:250,000 scale (Ministry of Forestry 2011a). To differentiate between dryland and peatland areas, we georeferenced the map sheets in Geographical Information System (GIS) and applied an image-classification algorithm to extract their dryland moratorium areas to a separate digital map (Text S1). We then labeled those features in the IPO map that were coincident with these extracted features as dryland moratorium forest, and all remaining features as peatland moratorium forest (Text S1). We removed from the moratorium reserves those areas designated as national parks or similar protected areas by the MoF (Minnemeyer *et al.* 2009), thereby excluding 180,208 km^2 of moratorium area.

Non-moratorium forest

The dryland non-moratorium forest and the peatland non-moratorium forest classes contain all remaining forests that might have been included within the moratorium reserves. The classes contain a mix of selectively logged forest, mature secondary (regrowth) forest, and limited primary forest demarcated via 2009 satellite-image interpretation by the MoF (Ministry of Forestry 2011b; Table S1). Notably, many scientists have called for the former forest types to be included within the Partnership, as they retain much of their original biomass and biodiversity (Butler 2010; Edwards *et al.* 2011a; Edwards & Laurance 2011; Murdiyarso *et al.* 2011). Our non-moratorium classes also exclude national parks and similar protected areas as well as concessions for oil-palm and timber-pulp plantations (Table S1).

Recently cleared forest

The recently cleared dryland forest and the recently cleared peatland forest classes experienced the loss of primary, selectively logged, or mature regenerating forest cover over 2003–2009. Being subject to deforestation and degradation, these forests are indicative of those ideally protected under REDD+. We defined these classes using satellite-derived forest maps of 2003 and 2009 from the MoF (Minnemeyer *et al.* 2009; Ministry of Forestry 2011b; Table S1).

We allocated areas of non-moratorium forest and recently cleared forest to either the dryland or peatland forest types, depending on whether they fall within or outside the peatlands mapped by WI (Wahyunto & Subagjo 2003, 2004, 2006; Table S1).

Attributes

We test for differences amongst our forest classes on the following attributes: (1) human population density (population/km^2) in 2000; (2) deforestation or forest degradation (average occurrence/20-km radius area) over 2000–2010; (3) distance to nearest settlement; (4) terrain marginality (defined by an interaction between elevation and slope); (5) forest-fire intensity (detected fires/km^2) over 2003–2007; (6) potential agricultural revenue (dollars/ha); and (7) road density (length/km^2), including logging roads, in 2003. We also considered distance to oil-palm or timber-plantation concessions as an attribute, but excluded it because of strong colinearity with attributes 2, 5, and 7.

Our attributes quantify features well known to influence the spatial variation of tropical deforestation and forest degradation, as evidenced by various spatial models of forest destruction (Hall *et al.* 1995; Cochrane & Laurance 2002, 2008; Laurance *et al.* 2002; Sloan 2011; Sloan & Pelleltier 2012). All attributes are spatially explicit and all but one (potential agricultural revenue) have <1-km spatial resolution. The deforestation/degradation, forest-fire intensity, and road-density attributes summarize the average trend of their respective phenomena over a 20-km radius area, but without spatial aggregation, to better reflect their spatially diffuse influence on risk to forest integrity. Text S1 provides further details on the attributes.

Sampling of grid cells

We constructed our sampling frame by overlaying a grid of 1-km^2 cells over Indonesia in a GIS and then recording for each cell its forest class and attribute values. A cell recorded the forest class that occupied the cell center. A further criterion was applied to the recently cleared forest classes, namely that they occupy ≥51% of a cell's area, to ensure that only reliable and significant instances of clearing were recorded. All cell values recorded the area-weighted mean value of attribute pixels within their extent.

From a large pool of cells, we randomly sampled 6,100 for the dryland classes and 2,159 for the peatland classes (Table 1). These samples are based on: (1) a minimum sample of 4% of the smallest dryland and peatland classes (Table 1), designed to minimize pseudoreplication and spatial dependence whereas still having a sufficient number of cases (Peduzzi *et al.* 1996); and (2) sample sizes for the other forest classes of ≤150% of those of the corresponding smallest class, to avoid biased assessments of predictive accuracy and again minimize pseudoreplication and spatial dependence. Sampling was stratified by Indonesia's major biogeographic regions: Sundaland, Wallacea, and New Guinea (Figure S1). The peatland classes were sampled exclusively from Sundaland and New Guinea, as Wallacea contains very little peatland.

Table 1 Number of 1-km^2 grid cells by forest class

Forest Class	*Total Cells*	*Sampled Cells*
Dryland Forest		
Moratorium Forest	366,428	2290
Non-Moratorium Forest	330,624	2285
Recently-Cleared Forest	38,104	1525
Dryland Total	735,156	6100
Peatland Forest		
Moratorium Forest	121,018	807
Non-Moratorium Forest	26,923	813
Recently-Cleared Forest	13,452	539
Peatland Total	161,393	2159

Statistical analysis

We developed spatially explicit logistic regression models to test for differences among forest classes. For dryland and peatland forests separately, the models predict the forest class of a cell given its attributes, for the pairwise comparisons of (1) moratorium versus non-moratorium forest, (2) moratorium versus recently cleared forest, and (3) non-moratorium versus recently cleared forest. The models include an autoregressive covariate accounting for spatial dependence among cells. Including this covariate, eliminated autocorrelation among residuals, improved classification accuracy, and reduced Type-I errors compared to a nonspatial model. Estimates are conservative with respect to attribute effect size and significance (Dormann 2007). The modeling was performed using the Spatial Analysis in Macroecology v.4.0 software (Rangel *et al.* 2010).

Results

Geographic situation of moratorium reserves

Simply by observing the geographic situation of dryland moratorium forests relative to both dryland non-moratorium forest and recently cleared dryland forest,

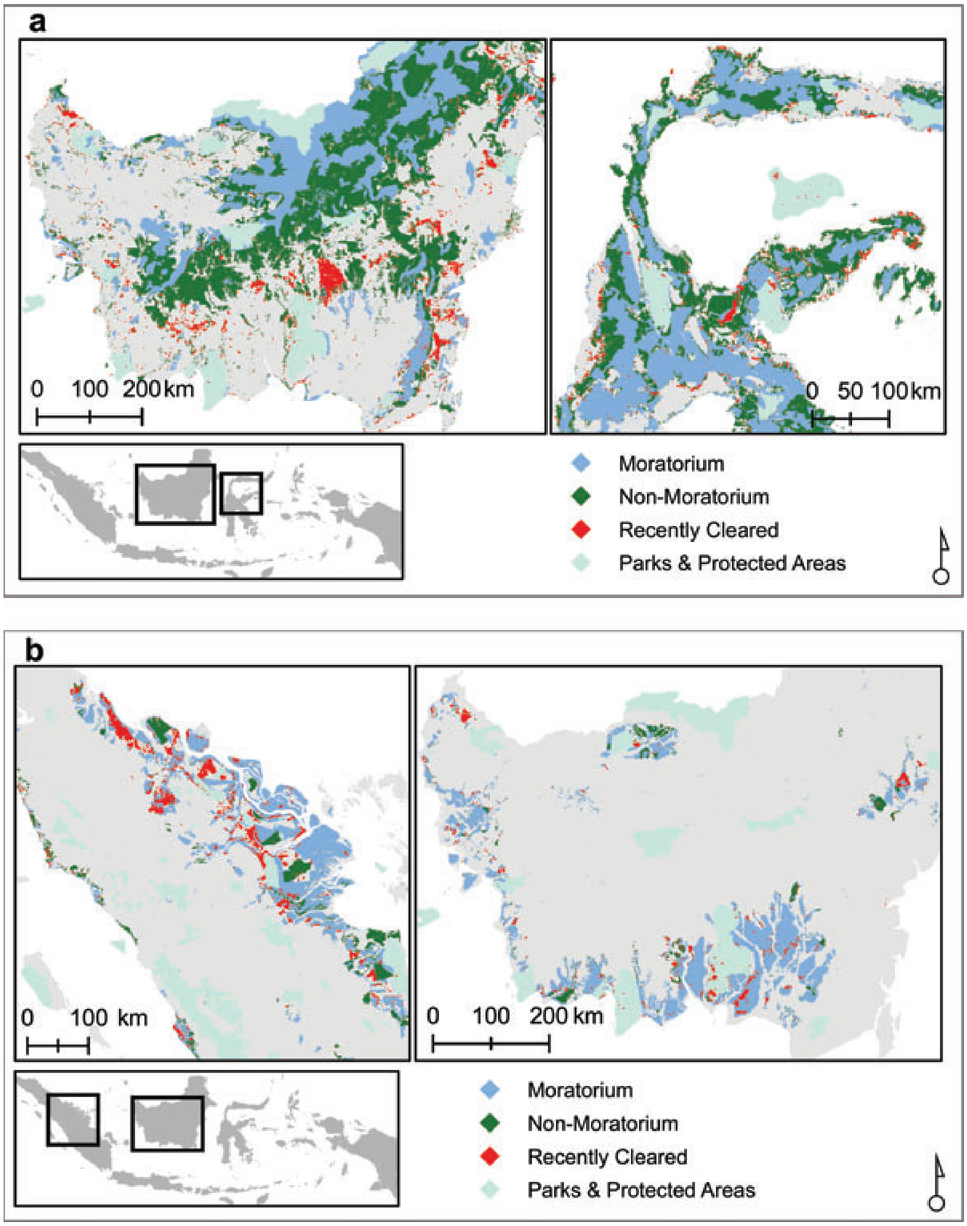

Figure 1 The geographic situation of the forest classes, for (a) dryland forests in Kalimantan (left) and Sulawesi (right), and (b) peatland forest in Sumatra (left) and Kalimantan (right). See Figure S2 for a national-scale map of the forest classes.

it is evident that the former is relatively marginal, that is, less amenable and/or accessible for forest conversion (Figures 1a and S2). Particularly in Kalimantan and Sulawesi, dryland moratorium reserves are in remote mountainous areas and often embedded within expanses of non-moratorium forest, which in turn are fringed by recently cleared forest extending toward zones of intense lowland agricultural activity (Figure 1a). Indeed, only 52% of the perimeter of the dryland moratorium forest class borders nonforest lands (i.e., cells for which we recorded no forest cover; total class perimeter = 137,199 cells), much of which are economically marginal. The remaining 48% of the class perimeter is buffered against the elevated risk of encroachment from the forest edge by other forest cover, namely dryland non-moratorium forest or protected forests (Figures 1a and S2). In comparison, the proportion of the dryland non-moratorium forest perimeter bordering nonforest lands is much higher,

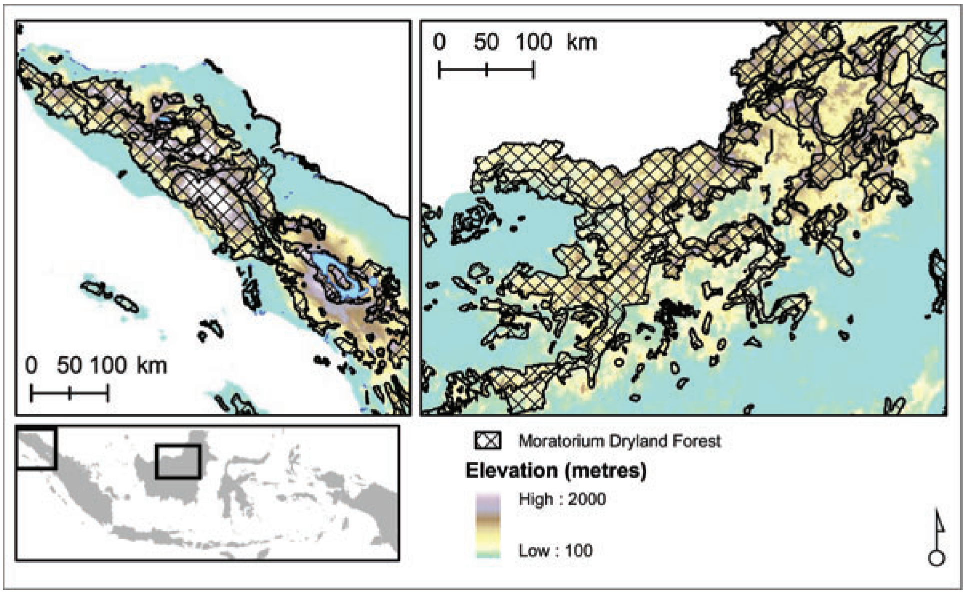

Figure 2 Dryland moratorium forest and elevation in Sumatra (left) and Kalimantan (right).
Note: Moratorium forest as mapped by the IPO (Presidential Working Unit 2011)

at 71% (total class perimeter = 157,784 cells). Moreover, the dryland moratorium areas tend to have higher elevations (Figure 2), which is also indicative of marginality, inaccessibility, and thus reduced threat.

A different situation is evident for the peatland moratorium forest reserves, however. Nationally, 71% of its perimeter borders nonforest land (total class perimeter = 57,235 perimeter cells; Figure S2). This is particularly apparent in Kalimantan and Sumatra, where the majority of peatlands remain (Figure 1b). Furthermore, all peat classes appear equally situated with regard to topography (Figure 1b).

Dryland forests

A logistic regression model predicting whether a cell contains moratorium or non-moratorium forest correctly classified 81% of cells considered, indicating significant differences in the attributes of the two classes (Table 2, Column I). Relative to non-moratorium forest, moratorium forest predominates in areas with significantly lower road densities (less physical accessibility), higher elevations and steeper slopes (greater marginality), lower potential agricultural revenue, and lower rates of deforestation or degradation, in order of effect size (Table 2, Column I). This agrees with the analysis of the geographic situation of the moratorium reserves (Figures 1a and 2) and again strongly suggests that dryland forest protected under the moratorium is more marginal and less threatened than the dryland forest excluded from the moratorium.

Interestingly, forest-fire intensity did not differ between moratorium and non-moratorium forest. Further, the effect of deforestation or degradation was relatively small. These observations might be explained by the relative spatial coarseness of these two attributes—their values summarize trends within a 20-km radius of a given point (Text S1)—but they might also mean that moratorium forest is not necessarily less proximate to these threats, where "proximity" is understood in terms of a 20-km radius.

Moratorium forest was also readily distinguishable from recently cleared forest (Table 2, Column II): 89% of cells were correctly classified, with again four of seven attributes significantly separating the classes. The most important attributes are, in order of effect size, road density, rate of deforestation/degradation, distance from settlements, and terrain marginality (Table 2, Column II). These are largely the same attributes that discriminated moratorium forest from non-moratorium forest (Table 2, Column I), but their effects are now greater, owing to the greater distance (both spatial and empirical) between moratorium forest and recently cleared forest.

Non-moratorium forest is also distinguished from recently cleared forest (Table 2, Column III), having fewer forest fires, lower rates of deforestation/degradation, a lower population density, and slightly less marginal terrain. This does not, however, mean that non-moratorium

Table 2 Standardized coefficients of logistic regression models. Significant coefficients are shown in **bold**

	Dryland forest						Peat forest					
	I Moratorium versus non-moratorium		II Moratorium versus recently cleared		III Non-moratorium versus recently cleared		IV Moratorium versus non-moratorium		V Moratorium versus recently cleared		VI Non-moratorium versus recently cleared	
Attribute	Coefficient[a]	T value	Coefficient	T value	Coefficient	T value	Coefficient	T value	Coefficient	T value	Coefficient	T value
Constant	0	−15.7**	0	−9.35**	0	−11.7**	0	−13.9**	0	−3.42**	0	−5.19**
Population density	0.17	1.93	−0.10	−0.59	**−0.50**	−2.28*	−0.26	−1.59	0.21	1.26	**0.80**	2.63**
Defor./degrad.	**−0.18**	−2.13*	**−0.74**	−5.05**	**−0.46**	−3.58**	**0.29**	1.99*	**−1.12**	−5.11**	**−1.14**	−3.69**
Dist. to settlements	0.1	1.14	**0.46**	3.29**	0.23	1.847	−0.12	−0.84	−0.17	−1.02	−0.13	−0.61
Terrain marginality	**0.64**	4.73**	**0.35**	1.96*	**−0.32**[c]	−3.36**	0.74	1.36	4.59	0.56	0.97	1.59
Forest fires	0.17	1.85	−0.29	−1.62	**−0.83**	−4.22**	0.26	1.36	−0.32	−1.39	**−0.91**	−2.38*
Agri. revenue	**−0.23**	−2.72**	−0.18	−1.386	0.01	0.087	0.02	0.16	0.08	0.53	−0.17	−0.86
Road density	**−0.7**	−7.52**	**−0.96**	−5.96 **	−0.01	−0.075	−0.05	−0.29	0.16	0.92	0.09	0.39
Autoregressive[b]	3.28	35.97**	4.39	28.68**	4.41	30.3**	4.02	22.87**	3.12	15.0**	4.79	17.79**
% Correctly classified	81		89		87		83		81		90	
N (cells)	4575		3815		3810		1620		1352		1346	

$^*p < 0.05$; $^{**}p < 0.01$.

[a]Standardized coefficients indicate the change in the logged odds that a cell contains the forest class of interest rather than the reference forest class, given a change of one standard deviation in an attribute, where the standard deviation is calculated over those cells considered in the model in question. The forest class of interest is the first class mentioned in the column header, and the reference class is the second class mentioned in the header, i.e., Moratorium versus recently cleared. Standardized coefficients facilitate the comparison attributes' effect size within a given model. [b]The spatial autoregressive covariate is given by **yW**, where **y** is the vector of the response variable and **W** is a $n \times n$ matrix describing the distance weight between the *i*th and *j*th cells, defined as per $W_{ij} = 1/d_{ij}^{\alpha}$ where an α of 2–3 was iteratively selected because it maximized classification accuracy. The "probability threshold" for a correct classification was 0.50. [c]Some caution is in order when interpreting this coefficient. Non-moratorium forest has appreciably higher elevations as well as steeper slopes on average relative to recently cleared forest; yet these traits interact more strongly within the latter class.

forest is unthreatened. Rather, there is a continuum of threat along which the relatively unthreatened moratorium forest, relatively threatened non-moratorium forest, and recently cleared forest classes are ordered, analogous to their relative location in Figure 1a (see above). Moratorium forest is distinguished from non-moratorium forest both geographically and empirically, and is further distinguished from recently cleared forests on similar attributes but to a greater degree.

Peatland forests

The models separating moratorium from non-moratorium peatland (Table 2, Column IV), moratorium from recently cleared peatland (Column V), and non-moratorium from recently cleared peatland (Column VI) all have high classification accuracies (range = 81–90%). However, this accuracy owes not to the attributes in the model, but rather to the autoregressive covariate accounting for the spatial clustering of cells of a given class. When the covariate is included, very few attributes distinguish these classes (Table 2). When removed, classification accuracies fall dramatically and approach random (kappa = 0.14–0.45). The peatland classes are therefore generally indistinct in terms of their degree of threat.

Numerous aspects of the peatland moratorium reserves indicate additionality in light of the similarity between the classes. First, of the 198,658 km^2 of peatlands (>50-cm deep) mapped by WI (Wahyunto & Subagjo 2003, 2004, 2006), an appreciable 115,168, km^2 are encompassed by our peatland moratorium forest class (Table S1). Second, the peatlands not encompassed by the moratorium invariably adjoin the reserves, as do recently cleared areas (Figure 1b), reflecting the spatial confinement of the peatland biome. This accounts for the similarity of the peatland classes on their threat attributes, and the power of the autoregressive covariate. Third, given satellite estimates that Indonesia lost 17% of its peatlands over 2000–2010, and up to 41% of those in Sumatra during this period (Miettinen *et al.* 2011), it is highly likely that even the temporary protection of such a large proportion of peatlands prevented imminent deforestation.

Caveats

The preceding is an empirical summary of a dynamic and variable landscape. In interpreting our findings we highlight two important caveats.

First, our findings reflect a national scenario guided by national priorities. Conclusions on the overall additionality of moratorium reserves generally do not apply equally to individual reserves. A relative few dryland reserves may indeed limit nearby threats (see discussion below and Murdiyarso *et al.* 2011), and a relative few peatland reserves may indeed face only limited threats. The potential existence of such reserves may be confirmed only on case-by-case basis, which is beyond the scope of our study. Their existence would not invalidate our findings, which again reflect a national reality determined by national priorities.

Second, the July 2011 moratorium map was updated in November 2011 (Ministry of Forestry 2011c). The updated map is largely identical to that of July 2011, save for 36,000 km^2 of peatland excised because of a more thorough accounting of preexisting licenses (Wells *et al.* 2011). This revision might enhance differences between the moratorium and non-moratorium peatland classes, yet its effect would probably be minor and unlikely to alter our observation that peatland reserves constitute genuine "additional" protection, given the above. Further regular updates to the map are planned.

Discussion

President Yudhoyono has expressed a strong desire to reduce forest destruction in Indonesia in favor of a carbon-saving REDD+ future (Murdiyarso *et al.* 2011; Yudhoyono 2011b). In support of this goal, in May 2010, Indonesia and Norway entered into an environmental partnership worth up to $1 billion over 2 years and with the possibility of further payments. However, a key deliverable of this partnership—a 2-year moratorium on the licensing of new concessions in peatlands and dryland forests—has been criticized for ignoring Indonesia's vast logged forests (Butler 2010; Edwards & Laurance 2011), with suggestions that much of the forest protected under the Partnership was not actually threatened (Edwards *et al.* 2011a; Murdiyarso *et al.* 2011; Austin *et al.* 2012). Here, we have rigorously assessed whether the moratorium forests constitute "additional" conservation and thus merit their share of the $1 billion from the Partnership leading to a REDD+ future.

Our analysis reveals both positives and negatives of the moratorium. On the positive side, the peatlands moratorium areas, which contain vast stores of carbon (Page *et al.* 2011), are not significantly different from unprotected or recently cleared peatlands in their degree of threat (Table 2). Moratorium peatlands encompass the majority of total peatland area (Table 1), with unprotected areas adjoining the moratorium reserves (Figure 1b). Therefore, considering the serious and extensive threats faced by peatlands (Miettinen *et al.* 2011), it is highly plausible that even the temporary protection of such a large proportion of peatlands constitutes additional conservation and forest-emission reductions.

On the negative side is the lack of additionality of dryland moratorium forests. These forests have less physical accessibility, lower rates of deforestation and degradation, steeper slopes, higher elevations, and less agricultural potential than do their unprotected and recently converted counterparts (Table 2). Further, they are also appreciably buffered against encroachment from the forest edge by adjacent forests. We have focused on moratorium forests outside of national parks and similar protected areas, but even many of these forests had some degree of legal protection before the Presidential Instruction (Murdiyarso *et al.* 2011). Hence, dryland moratorium areas were (and still are) both passively and actively protected against threat relative to other forest. These findings suggest that the ″conservation″ of the dryland moratorium forests will not meaningfully reduce deforestation or forest emissions relative to recent trends.

A failure to stem the conversion of dryland forests to agriculture in Indonesia (e.g., Gibbs *et al.* 2010; Miettinen *et al.* 2011) is of particular concern given that, by our conservative estimate, a vast expanse (330,624 km^2) of relatively threatened logged and secondary forest are excluded from the moratorium (Table 1). These forests retain much of their original biomass (Berry *et al.* 2010), such that failing to protect them will result in significant emissions of forest carbon (Edwards *et al.* 2011a; Koh *et al.* 2011). Furthermore, logged forests contain relatively high biodiversity (Cannon *et al.* 1998; Meijaard & Sheil 2008; Berry *et al.* 2010; Edwards *et al.* 2011b; Woodcock *et al.* 2011) and are a critical component of conservation strategies within Southeast Asia (Fisher *et al.* 2011).

Alterations to the moratorium forests

Our results do not imply that dryland moratorium forests need no protection. In time, most forest is threatened. Indeed, 28% of all moratorium areas fell within forest-use zones permitting logging or conversion in 2010 (zones are ″production forest,″ ″limited production forest,″ ″conversion forest,″ and ″areas for other uses″; Ministry of Forestry 2010). Still, as this statistic indicates, and as Murdiyarso *et al.* (2011) show in detail, the majority of moratorium forest enjoyed legal protections before 2011, to say nothing of the passive protection illustrated herein and typical of protected forests generally (Joppa & Pffaf 2009). The ecological virtues of primary forest merit conservation (Gibson *et al.* 2011); yet in the context of REDD+, of which the Indonesia–Norway Partnership is a precursor, conservation must reflect imminent threats of deforestation and a narrower focus on forest-emission reductions than traditionally (cf. Sangermano *et al.* 2012). Conservation divorced from imminent threat allows threat to materialize unimpeded and frustrate the specific goals of the Partnership and REDD+. Conservation must be planned and updated relative to threat.

Our results show that adjustments of the moratorium map are required for Indonesia to prevent further substantial forest emissions and capitalize on Partnership payments in preparation for REDD+. Although peatland moratorium areas almost certainly merit payments, these span only ~121,000 km^2 of Indonesia's forests outside of protected areas. We urge President Yudhoyono and the MoF to demarcate additional areas of threatened logged forests when updating the moratorium map.

We highlight the unprotected forests in the lowlands and foothills of Kalimantan as having significant potential as moratorium reserves. There, as many as 90,000 km^2 of logged forests are unprotected (Koh *et al.* 2011), relatively threatened (Table 2), and vulnerable to future encroachment (Figure 1a). Upon extending the moratorium to such forests, Indonesia would clearly illustrate the sincerity of its desire to reduce forest emissions, and no doubt increase its effectiveness in doing so. Without such inclusions, there is a serious risk that a lack of additionality will allow business-as-usual forest emissions in spite of the moratorium.

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Supporting Material

Additional Supporting Information may be found in the online version of this article:

Text S1: Description of forest cover and attribute data.
Table S1: Forest-class definitions.
Figure S1: Regional strata of Indonesia.
Figure S2: National distribution of moratorium forest, non-moratorium forest, and recently cleared forest, for (a) dryland forest, (b) peatland forest, and (c) both dryland and peatland forest types.

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