LETTER

Policy perils of ignoring uncertainty in oil palm research

Success of the emerging Low Emissions Development paradigm in Southeast Asia depends on mitigating impacts of oil palm (OP) expansion on carbon-dense ecosystems, especially tropical peatlands. To this end, Koh et al. (1) mapped OP planted before 2002 across Peninsular Malaysia, Sumatra, and Borneo to estimate emissions and biodiversity losses from peatland conversion (≈880,000 ha). Unfortunately, emissions scenarios are oversimplified, remote-sensing (RS) methods are unsuitable for OP monitoring, and recommendations for peatland restoration are overstated.

The article risks misinforming national and international climate change policies under development.

Koh et al. overestimated emissions from aboveground biomass (AGB) conversion to OP (136 million MgC) by assuming that all plantations replaced primary forest. Previous studies show that ≈40% of OP planted before 2000 replaced disturbed vegetation (2) with 40–97% less AGB than primary forest (180 MgC ha^{-1}). Accounting for alternative conversion pathways, we estimate emissions from AGB losses as 75–111 million MgC, 18–45% less than the authors' mean estimate.

Conversely, Koh et al. underestimated belowground C emissions. Potential emissions from burning for land clearing (100 ± 50 MgC ha^{-1}) were excluded from their analysis. Additionally, their C flux estimate from peatland oxidation (5.2 MgC $ha^{-1}y^{-1}$; based on two studies from Sarawak) is three- to fourfold lower than measurements collected across Southeast Asia at typical plantation water depths (14.9–23.6 MgC $ha^{-1}y^{-1}$) (3, 4). We estimate belowground C flux (annualized burning, oxidation, and foregone sequestration) as 15.3–26.9 million MgC $ha^{-1}y^{-1}$, ≈300–400% higher than the mean flux reported by the authors.

Their unique use of radar to map OP advances RS methods for regional land-cover inventories. However, this method is inadequate for monitoring "future land-use change driven by oil-palm" to "facilitate. . .sustainable development." In Indonesia, the ≈4.97 million ha of mature plantations mapped by Koh et al. in 2010 missed ≈2.7 million ha of OP evidently too young (<8 y) or in patches too small (<200 ha) to be detected with their methods. RS-based OP monitoring must identify OP expansion in real-time and at spatial resolution commensurate with OP development patterns [e.g., Landsat, Satellite Pour l'observation de la Terre (SPOT)].

Finally, the authors markedly overstated potential for rehabilitating ≈2.3 million ha of "clear-felled peatlands." First, most "cleared" areas may already be planted with OP. Recent work in Sarawak (www.sarvision.nl) shows that 65% of peatlands deforested from 2005 to 2010 were planted to OP and are unavailable for restoration. Additionally, rehabilitating deforested tropical peatlands is far more difficult and costly than appreciated (5). Enormous investments are required to raise water levels, control fires, and replant native species within the complex sociopolitical milieu of rural Southeast Asia. Finite dollars for peatland conservation must prioritize protecting forested peatlands, not restoring deforested ones.

We laud scientists like Koh et al., who wish to engage policymakers. However, clearly communicating uncertainties and assumptions of policy-oriented research is essential. Instead, the authors oversimplified a complex story, with no sensitivity analysis to explore uncertainty in peatland oxidation emissions or alternative land-cover change pathways preceding OP development. Southeast Asian countries developing emissions reductions strategies face tough choices balancing agricultural expansion with forest protection; proper treatment of uncertainty surrounding emissions from OP will help countries plan for worst- and best-case scenarios and design research aimed at informing policy decisions.

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LETTER

Reply to Paoli et al.: Explicit consideration of model uncertainties

Paoli et al. (1) raise some interesting criticisms of our article (2), but we think that they misinterpret important elements of our study, ignore our consideration of model uncertainties, and fail to recognize the wider significance of our work.

We presented a framework for quantifying the impacts of oil-palm expansion on biodiversity and carbon stocks. We did so by combining a unique remote-sensing methodology with a unique species-area model and recently published carbon flux estimates. We also explicitly accounted for and presented uncertainties in all model projections. We estimated that the conversion of peatswamp forests to large-scale, closed canopy oil-palm plantations within our study region resulted in a net loss of 136.6 $\pm$ 34.4 million Mg biomass carbon. The lower limit of this estimate falls within the range calculated by Paoli et al. (75–111 million Mg).

We acknowledge Paoli et al.'s criticism that we might have considered a larger set of data sources for peat oxidation estimates. We also recognize that burning contributes to regional carbon emissions to varying degrees but note that there currently is no reliable estimate of annual carbon emissions from peat fires. Therefore, we chose a conservative approach and excluded emissions from burning in our analysis; all assumptions of our calculations were clearly presented.

Because of persistent cloud cover in Southeast Asia, it is impossible to perform real-time oil-palm monitoring using high-resolution satellite imagery, as suggested by Paoli et al. At least 1–3 y of optical high-resolution data need to be collected for any regional assessment with reasonable data coverage. Even the most sophisticated cloud-penetrating radar-based methodologies would have to be used in combination with auxiliary datasets to delineate young oil-palm plantations.

Paoli et al. claim that 65% of peatlands deforested in Sarawak from 2005–2010 were planted with oil palm. The project they referred to actually mapped deforested areas that fell within the boundaries of oil-palm concessions. In certain parts of Southeast Asia, it may take years before oil palm is planted on deforested concession areas. Objective information on regional oil-palm distribution is still lacking. Without details and proper references, it is unclear how Paoli et al. derived their 2010 oil-palm plantation extents.

We recognize that forest restoration is costly. We did not, however, argue for peatland restoration over forest protection. In fact, we specifically recommended that both conservation and restoration efforts are required to safeguard the regional peatland ecosystems. Indeed, we are currently working with the United Nations Reducing Emissions from Deforestation and forest Degradation (REDD+) Program and the Indonesian REDD+ Task Force to assess the carbon and financial implications of imposing a proposed 2-y moratorium on forest conversion in Indonesia under alternative implementation scenarios.

We reiterate that our method provided an objective, remotely sensed distribution map of industrial-scale oil-palm plantations in Southeast Asia. We recognize the limitations of our methodologies, but our ongoing research, with our partners, will continue to improve our approach to meet the needs of the science and policy communities. In this capacity Paoli et al.'s comments are welcome, although we disagree with some of the details.

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