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REDUCING EMISSIONS FROM INDONESIA'S PEAT LAND: AN ASSESSMENT OF THE SCIENTIFIC ASPECT

Hernowo, B[1]., Rahayu, N.H.[1], Boer, R. [2,3] , Agus, F. [4], Ardiansyah, M. [2,5], Sabiham, S.[2,5], Mawdsley, N[6], Rahman, S. [7], Napitupulu, D. [7], and Ginting, I.[2]

SUMMARY

The development of Indonesia's peat land for the purpose of agriculture, palm cultivation and timber plantation is recognized as a source of greenhouse gas emissions. Current annual average emissions between 2000 and 2006 are estimated to be 928 $MtCO_2$/year and based on these trends, a Business as Usual (BAU) scenario is estimated to result in emissions of 1,077 $MtCO_2$ by 2025. By implementing best practice management of peat land, rehabilitation and revised land allocation policies, Indonesia is likely to have the potential to reduce its peat land emissions by up to 81 percent of the BAU scenario.

Keywords: Peat, BAU emissions, mitigation policies.

INTRODUCTION

Peat land provides various environmental services including, but not limited to, high carbon storage that could reach orders of magnitude higher than that of mineral land, the niche for thousands of flora and fauna species specific for peat land and protection of lowland landscapes from flood and drought risks (Parish *et al*., 2007, Agus and Subiksa, 2008). Estimates of the storage of carbon (C) in Indonesian peat land range from under 40 Gt C to around 55 Gt C (Wahyunto *et al*., 2003, 2004; Jaenicke *et al*., 2008).

Peat land is a marginal land for agricultural development. However the increasing need to produce food and fibre, as driven by population and consumption growth, has led this fragile environment to be used for economic development without full consideration of the long-term impacts. The process of degradation starts with timber harvest that, in most cases, requires drainage canals for the transportation of timber. Under agricultural systems, depending on the plant type, a deeper and denser drainage network may be required to enable root development and plant growth. Utilisation and drainage of peat land creates emissions of carbon dioxide from the above and below ground carbon pools through heterotrophic decomposition of peat and burning of plant biomass and peat (Hooijer, 2006; Agus and Subiksa, 2009; Agus *et al.*,

[1] National Development PlanningAgency (Bappenas), Jl. Taman Suropati No. 2, Jakarta 10310, Indonesia, +62-21-3926254, basahhr@gmail.com
[2] Center for Climate Risk and Opportunity Management in Southeast Asia and Pacific, Bogor Agricultural University
[3] Department of Geophysics and Meteorology Agriculture, Bogor Agricultural University
[4] Indonesian Center for Agricultural Land Resources Research and Development, Ministry of Agriculture
[5] Department of Soil Sciences and Land Resources, Bogor Agricultural University
[6] Independent
[7] Indonesia Ministry of Forestry

2009; Parish *et al*., 2007). Over the long-term, drainage will lead to significant subsidence of the peat land and irreversible changes in the topography of these low lying and mostly near-coastal areas that will lead to landscapes that are increasingly flood prone, can no longer be drained, and that will ultimately be abandoned.

Despite the fact that natural peat ecosystems are themselves carbon sinks, in terms of actions to mitigate emissions, it is only possible to reduce and avoid emissions, and once the peat forest is converted it is generally not possible to revert the land from a net C source into a net C sink. The scientific literature almost unanimously concludes that peat land in Indonesia is an important source of CO_2 emissions, as a result of the increasing rate of peat swamp forest clearance and utilization (Page *et al*., 2002; Hooijer *et al*., 2006; Bellassen *et al*., 2008), even the emission estimates varied considerable among studies.

Although deforestation, forest degradation and agricultural development in peat lands has contributed to economic development, it also causes GHG emissions as a result of (a) peat oxidation resulting from drainage, (b) dry season peat land fires and (c) loss of above-ground biomass (AGB) from non-fire related legal and illegal deforestation and degradation. Most agricultural crops grown in peat land require drainage. However, drainage of peat introduces oxygen into the surface, which promotes decomposition. The result is that (a) organic matter in the peat (carbon) is lost through oxidation and (b) the land surface subsides. Drainage and loss of forest creates degraded peat land that can become highly susceptible to fires lit in the dry season, especially in El Nino years, and canals and roads provide people with access. Fires lit to clear land by plantation companies and smallholder farmers as well as for other reasons can rapidly spread out of control. These fires create trans-boundary haze, at significant cost to the national economy, to the health of people and to efforts to tackle GHG emissions.

This study aimed to estimate the magnitude of historical and projected peat land emissions, identify possible mitigation acction, and assess the possible emission reduction potentials under different mitigation policy scenarios.

MATERIAL AND METHODS

Study Area

The study area is located in Indonesia’s peat land. Indonesia has around 21 million hectares of peat, distributed mostly in the eastern coastal plains of Sumatra (7.2 million ha), the western, southern and eastern coastal plains of Kalimantan (5.8 million ha) and in the southern coastal plains of Papua (8.0 million ha) (Wahyunto, 2003; 2004).

Assessment of Historical Land Use Changes

Assessment of historical land use changes was performed based on land cover/use maps from Indonesia Ministry of Forestry. The Ministry has regularly conducted land cover mapping, i.e. year 2000, 2003 and 2006, using Landsat 7 ETM+, Landsat 5 TM and SPOT 4 images. The land use transitions or changes were determined by overlaying land cover maps with peat land map, concession map and forest functions map.

Assessment of Historical and Future Emissions

Emission of CO_2 and removal from land use, land use change and forestry (LULUCF) was calculated from three processes, i.e. (a) emission and sequestration aboveground, (b) peat burning which may occur during land clearing or during extreme dry condition, and (c) peat decomposition.

The amount of net CO_2 emission above ground, S_a, can be calculated as:

$$S_a = A_p * (C_b - C_a) * 3.67$$

Where A_p is area under certain land use change, C_b is the C stock before conversion or before land use change and C_a the C stock after a certain period of year (in this case, in general we take annual average based on 25 year cycle).

Emission from peat burning, E_b, can be calculated as:

$$Eb = h_b * A_b * BD * C * 3.67$$

Where h_b is the thickness of burned peat, A_b is the area burned, BD is peat bulk density, and C is peat C content (weight basis).

Peat decomposition used Couwenberg et al. (2010) relationship as

$$E_d = 0.4 * A_d * h_d * BD * C * 3.67$$

Where the index 0.4 indicates the decomposition portion of subsidence, A_d area of decomposed peat, h_d is depth of peat subsidence, BD is peat bulk density, and C is peat C content (weight basis).

RESULTS

Emissions from Peat Land

Current annual average emissions between 2000 and 2006 are estimated to be 928 $MtCO_2$ per year. The major sources of emissions from peat land historically are (a) oxidation contributing 338 $MtCO_2$ per year, (b) fire (controlled and uncontrolled burning) contributing 330 $MtCO_2$ per year and (c) the loss of above-ground biomass from deforestation and degradation contributing 260 $MtCO_2$ per year (Figure 1).

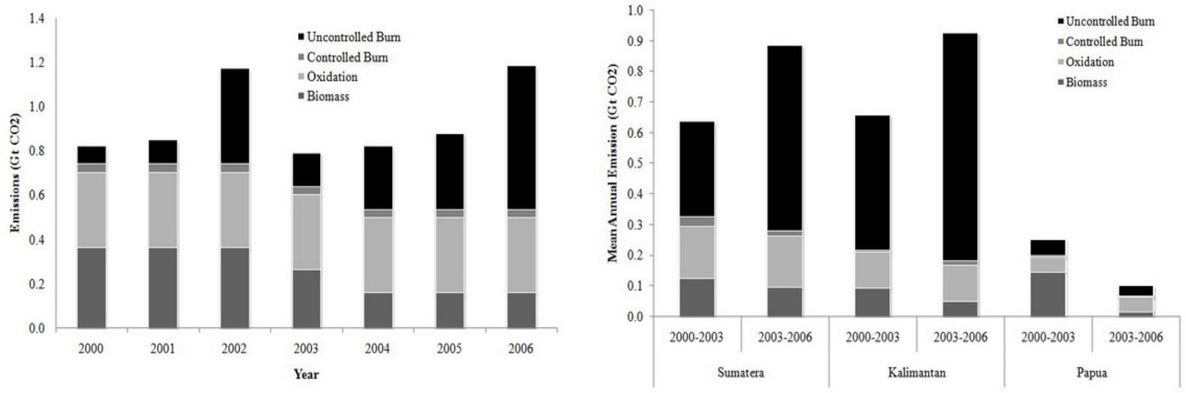

Figure 1. Estimated carbon emissions from Indonesia's peat lands as a result of loss of above-ground biomass, peat oxidation and fires (controlled and uncontrolled) (left) and their source area (right)

Based on current trends, a Business as Usual (BAU) scenario is estimated to result in emissions of 1,077 MtCO_2 by 2025. However, the emissions profile is expected to change in the future BAU scenario as a result of changing land use. In 2025, oxidation is expected to account for 51 percent of emissions with anthropogenic wildfire accounting for just 21 percent, which reflects a 'peat land use transition'. The overall increase in emissions highlights that while the cultivation of peat land may reduce fire emissions it is unlikely to result in a net decrease of emissions due to the increased emissions from oxidation.

Policy Options for Reducing Emissions in Peat Land

Indonesia has the potential to reduce emissions from its peat land but this will require a range of possible mitigation actions. Considering policies and new regulations issued by government related to peat land management and potential options for reducing emission from peat land, three three mitigation policies were developed combined with nine mitigation actions. Each mitigation action is sequentially added from 1-9 to create nine mitigation scenarios.

- Mitigation Policy 1: Enforcement of existing legal requirements and establishment of new standards for best practices in 'low carbon' peat land management. The four actions defined in this policy option include: (1) compliance to 3m peat depth for development, (2) zero burning for land clearance, (3) water management through controlled drainage and (4) the addition of soil ameliorant.
- Mitigation Policy 2: Reducing emissions through an integrated approach to effective peat management. There area two mitigation actions under this policy: (5) peat land hydrological rehabilitation, fire prevention and control and (6) peat land reforestation.
- Mitigation Policy 3: Reducing emissions through redirecting economic land use away from peat land to mineral soils. Three mitigation actions under this policy are defined: (7) conservation of non-licensed peat forest, (8) protection and rehabilitation of non-licensed peatland, and (9) the relocation (land swaps) of inactive licenses from peat land to suitable mineral land locations.

Potential Emission Reduction from Peat Land

The potential emissions under each of three nested main policy measures are estimated and compared to the BAU scenario. It should, however, be emphasized that as a result of the nesting of these actions that these results are dependent on the sequencing of the actions. Based on the sequence adopted in this study, the results from this analysis show that:

- *Legal compliance and best management practices in existing land under production* could yield 291 Mt CO_2 emission reductions by 2025 (27 percent of potential reductions).
- *Peat land rehabilitation and prevention of uncontrolled fires* potentially may add a further 243 Mt CO_2 emission reductions (23 percent of potential reductions).
- *Revision of land allocation, forest conservation and land swaps* that direct future development away from peat land could create an additional 344 Mt CO_2 emission reductions (32 percent of potential reductions).

CONCLUSION

This study has presented results that show Indonesia has the potential to make significant reductions in emissions from peat land. Historical peat land emissions of 928 million tons

CO_2 per year as estimated by this study are dominated by oxidation (36 percent) and anthropogenic wild fire emissions (31 percent) followed by deforestation and degradation (28 percent) and controlled burning in concession areas (4 percent) from deforestation and forest degradation. Current emissions come mostly from deep peat land in Sumatra and Kalimantan, whereas Papua has extensive shallow peat lands with the potential to increase Indonesia's emissions if they are developed in the future.

Indonesia has the potential to make significant reductions in its peat land emissions – by up to 82 percent of the Business as Usual scenario – through compliance and best management practices in plantations, peat land rehabilitation and the revision of spatial plans to conserve existing forest and unlicensed peat land combined with relocation of existing licenses that are not operational to mineral soils.

Avoiding large-scale development of peat land areas will not only reduce emissions from peat land but will also reduce the other future costs that Indonesia will bear as a result of peat land development. Critical amongst these is the fact that peat land drainage is not sustainable – oxidation and subsidence are the inevitable side effects of this as shown by experience internationally such as the Everglades of Florida, where realisation of this process changed the policy of peat land use. The consequence for Indonesia is that at some point in the future, subsidence will lead to the existing peat land under cultivation being no longer drainable and increasingly flood-prone, which will only be accelerated by sea level rise. The only debatable question is when – but this will most likely be reached in terms of just a few decades not centuries.

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