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INDUSTRIAL PLANTATIONS ON SOUTHEAST ASIAN PEATLANDS: 2010 SITUATION WITH ANALYSIS OF HISTORICAL EXPANSION AND FUTURE PROJECTIONS

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SUMMARY

In this paper we present the extent of industrial plantations in 2010, their historical expansion and projections for future development on Southeast Asian peatlands. The analysis is based on visual interpretation of high resolution satellite images. Industrial plantations covered over 3.1 Mha (20%) of the peatlands of Peninsular Malaysia, Sumatra and Borneo in 2010. Historical analysis shows strong acceleration of plantation development in recent years: 70% of all industrial plantations have been established since 2000 and only 4% of the current plantation area existed in 1990. Projections of future conversion rates indicate that 6-9 Mha of peatland in insular Southeast Asia may be converted to plantations by the year 2020. Subsequently, the associated annual carbon emissions from peat decomposition in industrial plantations would increase from the current 230 Mt CO_{2e} to over 450 Mt CO_{2e}.

KEY WORDS: tropical peatland, peatland conversion, plantation development

INTRODUCTION

Recent assessments of peatlands in insular Southeast Asia have revealed dramatic reduction of peat swamp forest cover since 1990 (Miettinen and Liew, 2010; Miettinen *et al.*, 2011). Conversion of peat swamps to industrial plantations is often seen as one of the major causes of deforestation. In particular, oil palm cultivation for biofuel production has caused much controversy. In spite of the various numbers used by parties in the ongoing debate on plantation agriculture on Southeast Asian peatlands and its potential regional and global level effects, there is little objective information available on the extent of oil palm and other types of industrial plantations on insular Southeast Asian peatlands.

In this study we investigate the extent of oil palm, pulp and other types of industrial plantations on the peatlands of Peninsular Malaysia, Sumatra and Borneo. We report the extent and spatial distribution of industrial plantations in 2010 and analyse the historical

development trends of industrial plantation agriculture since 1990. Finally, we derive projections for near-future plantation expansion on the peatlands of insular Southeast Asia.

MATERIAL AND METHODS

Peatland areas in Sumatra and Kalimantan (Indonesian part of Borneo Island), were outlined using the Wetlands International 1:700 000 peatland atlases (Wahyunto *et al.*, 2003; 2004). For Malaysia, information on the extent of peatlands was derived from the European Digital Archive of Soil Maps (Selvaradjou *et al.*, 2005) as described in (Miettinen and Liew, 2010).

For the 2010 mapping of industrial plantations 100% of peatland areas were covered with 74 Landsat 7 ETM+ images acquired between 1st January 2010 and 11th March 2011. Industrial plantations were manually delineated on screen based on visual interpretation of the images in 1:50 000 scale. For the historical analysis of the expansion of industrial plantations, the extent of plantation areas in 1990 and 2007 was derived from the land cover maps created by Miettinen and Liew (2010). The 2000 plantation mapping was performed using the same methodology as the 2010 mapping but with the 2000 GeoCover product. For the historical analysis, the overlapping valid data coverage over all observed time slices was 81% of peatlands in the study area.

Very high resolution satellite imagery acquired between 2004 and 2010 available in Google Earth was utilised to evaluate the accuracy of the methodology used in this study by comparing the very high resolution samples to the 2007 map. The data covered 4% of the peatlands spread around 30 different sites. Within these sampling sites, 600 sample plots were selected using stratified random sampling and the accuracy of the methodology was found to be adequate (overall accuracy 94%, kappa 0.91) for reliable analysis on plantation extent and expansion.

The projections of the potential expansion of industrial plantations by 2020 were based on recent expansion trends. The simplest (steady increase) projection assumed that plantation extent in coming years would expand at the same rate as it did in the most recent period of analysis, 2007-2010. A second model was derived by using the degree to which the increase from 2000 to 2010 had been greater than that over the 1990s. This takes into account the longer-term acceleration but still not the sharp acceleration in plantation development that has happened since 2007.

Recent extensive field analyses on CO_2 emission from plantations on tropical peatland (Hooijer *et al.*, 2011; Jauhiainen *et al.*, 2011) conclude that unit emissions at five or more years after drainage can be considered to be 75 t ha^{-1} y^{-1} at water table depths around 0.75 m that are representative for actual conditions in many relatively well-managed plantations. This estimate agrees well with earlier findings in the region (Couwenberg *et al.*, 2010; Hooijer *et al.*, 2010). However, if the initial high carbon emission peak occurring within the first four years after the establishment of the plantation (Hooijer *et al.*, 2011) is included, plantations can be expected to emit 100 t ha^{-1} y^{-1}, calculated as an average over a 25 year period after drainage. These numbers were multiplied with the number of hectares of plantation. It is important to understand that our emission estimates are based on the actual plantation area coverage and do not take into account impacts beyond the limits of the plantations.

RESULTS

Our results show that over 3.1 Mha of peatland had been converted to industrial plantations by 2010 (Table 1), equal to 20% of peatlands in the study area. Over 60% of the plantations were found in Sumatra Island which contains less than half (47%) of peatlands in the study area. In Sarawak and Sabah, 36% and 27% of peatlands had been converted to plantations respectively. Overall, Riau and South Sumatra provinces in Sumatra and Sarawak state in Borneo contained 62% of all industrial plantations in the region. Over two thirds (69%) of all industrial plantations in 2010 were used for oil palm cultivation, with the remainder being mainly pulp wood (27%) and a small extent of other (4%) plantations.

Table 1. Distribution of industrial plantations (IP) in the peatlands of Peninsular Malaysia, Sumatra and Borneo in 2010.

	Area (1000ha)	% of IP within island	% of IP within study area	IP % of total peatland
Peninsular Malaysia	262	n.a.	8	29
Aceh	*46*	*2*	*1*	*17*
North Sumatra	*200*	*10*	*6*	*57*
Riau	*968*	*51*	*31*	*24*
West Sumatra	*89*	*5*	*3*	*42*
Jambi	*146*	*8*	*5*	*20*
Bengkulu	*7*	*0*	*0*	*13*
South Sumatra	*449*	*23*	*14*	*31*
Lampung	*10*	*1*	*0*	*11*
Total Sumatra	1915	100	62	26
Sarawak	*525*	*56*	*17*	*36*
Sabah	*52*	*6*	*2*	*27*
West Kalimantan	*157*	*17*	*5*	*9*
Central Kalimantan	*118*	*13*	*4*	*4*
South Kalimantan	*31*	*3*	*1*	*10*
East Kalimantan	*53*	*6*	*2*	*8*
Total Borneo	936	100	30	13
Total study area	3113		100	20

Apart from Peninsular Malaysia, where plantation agriculture on peatlands was already well established by 1990, nearly all peatland plantations have been created over the past 20 years (Fig. 1). Furthermore, plantation development has accelerated fast with 70% of plantations established over the decade 2000 - 2010 and 27% within the three years of 2007 – 2010 alone. The acceleration of plantation development since 2000 has been particularly fast in South Sumatra, Riau and Sarawak which together accounted for 75% of all new plantations established since 2000.

Based on two different projection models (steady increase and decadal acceleration) we estimated that in 2020 industrial plantations would cover between 6.0 and 9.2 Mha of peatland in the study area (Fig. 1). Further analysis on potential limitations for future expansion (Hooijer *et al.*, in press) revealed that in no Province in Indonesia, nor in the Malaysian States in Borneo, would the total peatland area limit further expansion by 2020.

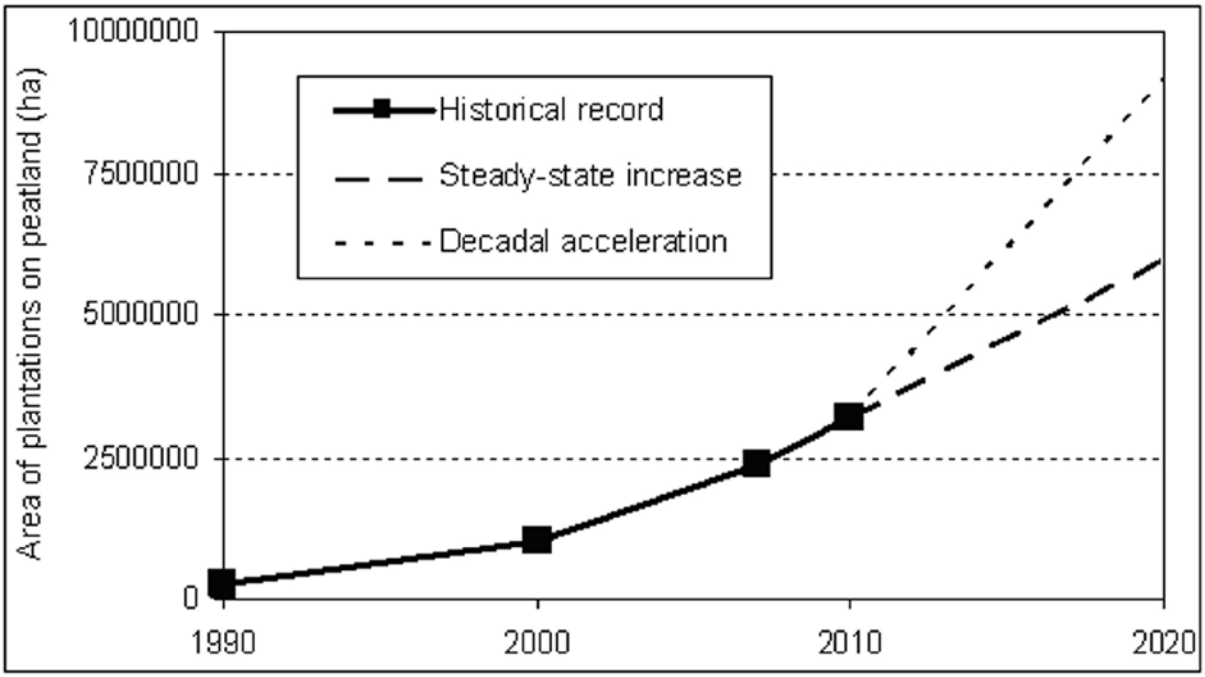

Figure 1. Expansion of industrial plantations on peatland in Sumatra, Borneo and Peninsular Malaysia since 1990 and projection of future expansion until 2020.

For Indonesia, the projection was also tested against land allocation maps for 2011, and it was found that the area allocated for plantation expansion would easily accommodate this projection. This may not, however, be the case in some parts of Malaysia where available land resources are scarcer.

It was estimated that the industrial plantation area of 2010 produces a carbon emission to the atmosphere of at least 233 Mt y^{-1} CO_2 equivalents, up from 79 Mt y^{-1} by 2000 and 20 Mt y^{-1} by 1990. Of the total emission in 2010, 161 Mt y^{-1} (69%) is caused by oil palm plantations. If the initial emission peak noticed by Hooijer et al. (2011) is included, and the total emissions are averaged over a 25 year period, the yearly emissions from the total plantation area in 2010 would reach up to 311 Mt y^{-1}. Depending on the projection method, the 2020 emission from industrial plantations on peatlands in this part of Southeast Asia would be somewhere between 447 Mt y^{-1} and 688 Mt y^{-1} CO_2 equivalents according to the lower estimate and between 596 Mt y^{-1} and 917 Mt y^{-1} if the initial peak in emissions is included.

DISCUSSION AND CONCLUSION

The results reported in this paper highlight the accelerating nature of industrial plantation expansion on peatland since 1990. Projections indicate that half of the peatland area on the islands of Sumatra and Borneo and in Peninsular Malaysia may be covered by plantations by 2020 if current expansion trends persist. Furthermore, under current policies, there is no indication that expansion will stop in 2020. This expansion is also likely to result in degradation well beyond the plantation limits as peatland drainage and access roads have an impact over at least two kilometres (Hooijer *et al.*, 2011). Bearing in mind that other causes of peatland deforestation, including small-holder agriculture and logging, are also still expanding, it would appear that very little peatland forest is likely to remain in Southeast Asia

by the end of the current decade unless land use planning policies are changed or markets for palm oil and pulp products from these areas are reduced.

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