APPENDIX 2 - Indonesia

Table A2.1. Carbon debt calculation of the Manokwari, Indonesia case

			estimates					references
Carbon debt due to conversion of primary lowland tropical rainforest								
Aboveground carbon stock loss	193.3	Mg C ha-1	*236*	*269.7*	*160.9*	*120.8*	*179*	Fox et al. 2010; Bryan et al. 2010; Fargione et al. 2008
-19% forest products	36.7	Mg C ha-1						Fargione et al. 2008
subtotal	**156.6**	**Mg C ha-1**						
Belowground carbon stock loss								
biomass	46.6	Mg C ha-1	*13%*	*21%*	26%	23.5%	37%	Fargione et al. 2008
soil	18.2	Mg C ha-1						IPCC 2006
subtotal	**64.8**	**Mg C ha-1**						
Carbon stocked in oil palm plantation	**35.8**	**Mg C ha-1**	*36*	*31.5*	*40*			Pereira de Souza et al. 2010; Murdiyarso et al. 2010; Germer & Sauerborn 2008; Fargione et al. 2008
Total carbon debt	**185.5**	**Mg C ha-1**						
	681.7	**Mg CO2 ha-1**						
Carbon debt due to conversion of secondary lowland tropical rainforest								
Aboveground carbon stock loss	99.2	Mg C ha-1	*99.2*					Fox et al. 2010; Bryan et al. 2010; Fargione et al. 2008
- 19% forest products	18.8	Mg C ha-1						Fargione et al. 2008
subtotal	**80.4**							
Belowground carbon stock loss								
biomass	23.9	Mg C ha-1	*13%*	*21%*	26%	23.5%	37%	Fargione et al. 2008
soil	18.2	Mg C ha-1						IPCC 2006
subtotal	**42.1**	**Mg C ha-1**						

Table A2.1. continued Carbon debt calculation of the Manokwari, Indonesia case

			estimates			references
Carbon stocked in oil palm plantation	**35.8**	**Mg C ha-1**	*36*	*31.5*	*40*	Pereira de Souza et al. 2010; Murdiyarso et al. 2010; Germer & Sauerborn 2008; Fargione et al. 2008
Total carbon debt	**86.6**	**Mg C ha-1**				
	318.4	**Mg CO2 ha-1**				
Carbon debt due to conversion of agricultural land						
Total carbon debt						
biomass	-16.4	Mg C ha-1				ENCOFOR tool
soil C (20 yr)	-10.2	Mg C ha-1				IPCC 2006
Total carbon debt	**-26.6**	**Mg C ha-1**				
	-97.9	**Mg CO2 ha-1**				

Table A2.2. Carbon debt calculation of the Kubu Raya, West Kalimantan, Indonesia case

Carbon debt due to conversion of peat swamp forest

			estimates						references
Aboveground carbon stock loss	163.0	Mg C ha-1	*179.2*	*130*	*179.7*				Brealey et al. 2004; Miettinen & Liew 2009; Murdiyarso et al. 2010
- 19% forest products	31.0	Mg C ha-1							Fargione et al. 2008
subtotal	**132.0**	**Mg C ha-1**							
Belowground carbon stock loss									
biomass	39.3	Mg C ha-1	*13%*	*21%*	26%	23.5%	37%		Fargione et al. 2008
emission from peat (25 years)	362.6	Mg C ha-1	*10.8*	*16.2*	*19.9*	*14.8*	*10.0*	*15.4*	Murdiyarso et al. 2010; Hergoualc'h & Verchot 2011; Fargione et al. 2008
subtotal	**401.8**	**Mg C ha-1**							
Carbon stocked in oil palm plantation	**35.8**	**Mg C ha-1**	*36*	*31.5*	*40*				Pereira de Souza et al. 2010; Murdiyarso et al. 2010; Germer & Sauerborn 2008; Fargione et al. 2008
Total carbon debt	**498.0**	**Mg C ha-1**							
	1830.2	**Mg CO2 ha-1**							

Carbon debt due to conversion of peat swamp

emission from peat (25 years)	362.6	Mg C ha-1	*10.8*	*16.2*	*19.9*	*14.8*	*10.0*	*15.4*	Murdiyarso et al. 2010; Hergoualc'h & Verchot 2011; Fargione et al. 2008
Total carbon debt	**362.6**	**Mg C ha-1**							
	1332.5	**Mg CO2 ha-1**							

Carbon debt due to conversion of agricultural land

Total carbon debt			
biomass	-16.4	Mg C ha-1	ENCOFOR tool
soil C (20 yr)	-10.2	Mg C ha-1	IPCC 2006

Table A2.2. continued Carbon debt calculation of the Kubu Raya, West Kalimantan, Indonesia case

Total carbon debt	**-26.6**	**Mg C ha-1**
	-97.9	**Mg CO2 ha-1**

Table A2.3. Carbon debt calculation of the Boven Digoel, Papua, Indonesia case

Carbon debt due to conversion of primary lowland tropical rainforest Papau, Indonesia									
			estimates						**references**
Aboveground carbon stock loss	193.3	Mg C ha-1	*236*	*269.7*	*160.9*	*120.8*	*179*		Fox et al. 2010; Bryan et al. 2010; Fargione et al. 2008
-19% forest products	36.7	Mg C ha-1							Fargione et al. 2008
subtotal	**156.6**	**Mg C ha-1**							
Belowground carbon stock loss									
biomass	46.6	Mg C ha-1	*13%*	*21%*	26%	23.5%	37%		Fargione et al. 2008
soil	18.2	Mg C ha-1							IPCC 2006
subtotal	**64.8**	**Mg C ha-1**							
Carbon stocked in oil palm plantation	**35.8**	**Mg C ha-1**	*36*	*31.5*	*40*				Pereira de Souza et al. 2010; Murdiyarso et al. 2010; Germer & Sauerborn 2008; Fargione et al. 2008
Total carbon debt	**185.5**	**Mg C ha-1**							
	681.7	**Mg CO2 ha-1**							
Carbon debt due to conversion of peat swamp forest									
Aboveground carbon stock loss	163.0	Mg C ha-1	*179.2*	*130*	*179.7*				Brealey et al. 2004; Miettinen & Liew 2009; Murdiyarso et al. 2010
- 19% forest products	31.0	Mg C ha-1							Fargione et al. 2008
subtotal	**132.0**	**Mg C ha-1**							
Belowground carbon stock loss									
biomass	39.3	Mg C ha-1	*13%*	*21%*	26%	23.5%	37%		Fargione et al. 2008
emission from peat (25 years)	362.6	Mg C ha-1	*10.8*	*16.2*	*19.9*	*14.8*	*10.0*	*15.4*	Murdiyarso et al. 2010; Hergoualc'h & Verchot 2011; Fargione et al. 2008
subtotal	**401.8**	**Mg C ha-1**							

Table A2.3. continued Carbon debt calculation of the Boven Digoel, Papua, Indonesia case

			estimates						references
Carbon stocked in oil palm plantation	**35.8**	**Mg C ha-1**	*36*	*31.5*	*40*				Pereira de Souza et al. 2010; Murdiyarso et al. 2010; Germer & Sauerborn 2008; Fargione et al. 2008
Total carbon debt	**498.0**	**Mg C ha-1**							
	1830.2	**Mg CO2 ha-1**							
Carbon debt due to conversion of peat swamp									
emission from peat (25 years)	362.6	Mg C ha-1	*10.8*	*16.2*	*19.9*	*14.8*	*10.0*	*15.4*	Murdiyarso et al. 2010; Hergoualc'h & Verchot 2011; Fargione et al. 2008
Total carbon debt	**362.6**	**Mg C ha-1**							
	1332.5	**Mg CO2 ha-1**							
Carbon debt due to conversion of agricultural land									
Total carbon debt									
biomass	-16.4	Mg C ha-1							ENCOFOR tool
soil C (20 yr)	-10.2	Mg C ha-1							IPCC 2006
Total carbon debt	**-26.6**	**Mg C ha-1**							
	-97.9	**Mg CO2 ha-1**							

LITERATURE CITED

Brearley, F. Q., S. Prajadinata, P. S. Kidd, J. Proctor, and Suriantata. 2004. Structure and floristics of an old secondary rain forest in Central Kalimantan, Indonesia, and a comparison with adjacent primary forest. *Forest Ecology and Management* 195:385-397.

Bryan, J., P. Shearman, J. Ash, and J. B. Kirkpatrick. 2010. Estimating rainforest biomass stocks and carbon loss from deforestation and degradation in Papua New Guinea 1972-2002: best estimates, uncertainties and research needs. *Journal of Environmental Management* 91:995-1001.

Fargione, J., J. Hill, D. Tilman, S. Polasky, and P. Hawthorne. 2008. Land clearing and the biofuel carbon debt. *Science* 319:1235-1238.

Fox, J. C., C. K. Yosi, P. Nimiago, F. Oavika, J. N. Pokana, K. Lavong, and R. J. Keenan. 2010. Assessment of aboveground carbon in primary and selectively harvested tropical forest in Papua New Guinea. *Biotropica* 42:410-419.

Germer, J. and J. Sauerborn. 2008. Estimation of the impact of oil palm plantation establishment on greenhouse gas balance. *Environment, Development and Sustainability* 10:697-716.

Hergoualc'h, K. and L. V. Verchot. 2011. Stocks and fluxes of carbon associated with land-use change in Southeast Asian tropical peatlands: a review. *Global Biogeochemical Cycles* in press.

IPCC. 2006. *Guidelines for National Greenhouse Gas Inventories*

Miettinen, J. and S. C. Liew. 2009. Estimation of biomass distribution in Peninsular Malaysia and in the islands of Sumatra, Java and Borneo based on multi-resolution remote sensing land cover analysis. *Mitigation and Adaptation Strategies for Global Change* 14:357-373.

Murdiyarso, D., K. Hergoualc'h, and L. V. Verchot. 2010. Opportunities for reducing greenhouse gas emissions in tropical peatlands. *Proceedings of the National Academy of Sciences of the United States of America* 107:19655-19660.

Pereira de Souza, S., S. Pacca, M. Turra de Avila, and J. L. B. Borges. 2010. Greenhouse gas emissions and energy balance of palm oil biofuel. *Renewable Energy* 35:2552-2561.