Assessment of emission scenarios for 2030 and co-benefits of black carbon emission reduction measures on air quality and climate forcing in Southeast Asia

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Table S1: Description of mitigation measures for RED2030 Scenario for Indonesia and Thailand.

No	Sector	Description of RED2030 measures	
		Indonesia	Thailand
1	Transportation	All personal cars would have to comply with Euro2 in 2030[a]	All personal cars <1,600 CC in the market in 2030 would have fuel consumption 5 liters/100 km and would comply with Euro4 standard[e]
		100% of public diesel buses would be shifted to CNG[b]	Implementation of cleaner fuel of CNG for all public buses and taxi in 2030[f]
2	Residential	Full implementation of "zero kero" program to cover 42 million (64%) households converted from kerosene to LPG by 2012 and 80% of number of households as end-point (by 2030)[c]	50% of total fuel consumption of wood and charcoal in 2030 would be converted to LPG[f]
		Substitution of traditional fuel wood cook stoves to cleaner biomass stoves (gasifier stoves)[b]	Electricity to replace biomass (in 2030 20% of fuel wood would be converted to electricity)[f]
3	Industry	Fuel switch from coal to biomass and natural gas for cement, iron steel, pulp and paper, and textiles and fertilizer industries[b]	Increasing efficiency of boilers (new rotary burners) and furnaces (by preheating fuel) that could save energy of around 16% by 2030[e]
		Modernization of process from wet to dry kiln in cement industry and increasing efficiency of boilers and furnace that could save energy around 16% by 2030[b]	Full implementation of maximum feasible reduction (application of air pollution control devices) in cement and iron industry by 2030[e]
4	Biomass open burning	20% reduction of burned area for forest fire and crop residue open burning in 2014 and around 40% in 2030 as compared to the year of 2010[d] (National strategic plan 2010)	Forest area burned would not be over than 48,000 ha y^{-1} (2030)[g] (National master plan)
		Zero burning of solid waste by 2030 due to improved SW management in most of urban areas[c]	Zero burning policy to re-use of crop residue as bio-energy up to 25% from total energy demand in 2030[g]
			Amount of solid waste subjected to burn should be reduced at least 75% through adequate solid waste management system in 2030[g]

Source:
[a] Clean Air Asia (CAI, 2010). Roadmap of Euro standard in Asian Countries.
[b] Indonesia Climate Change Sectoral Roadmap (ICCSR, 2010).
[c] Energy Sector Management Assistance Program (ESMAP, 2012). Low carbon country studies: Indonesia.
[d] Ministry of Forestry (MoF, 2010). Strategic Plan 2010-2014. Converted from number of hotspot (active fire count) to the burned area.
[e] Chotichanatawewong and Thongplew (2012). Development trajectory, emission profile and policy actions.
[f] Department of Alternative Energy Development and Efficiency (DEDE, 2009). Renewable Energy Development Plant.
[g] National Master Plan of Open Burning in Thailand. PCD (2007).

Table S2: Summary of projected activity data collected for BAU2030

No	Activity data	Indonesia	Thailand	2030/2007 ratio (Indonesia)	2030/2007 ratio (Thailand)
1	Population	1998-2007[a]	1994-2007[e]	1.8	1.3
2	Total number of motor vehicles	1998-2007[b]	1988-2007[f]	3.1	2.2
3	Total crop production	1998-2007[a]	1996-2007[g]	1.4	1.2
4	Livestock population	1998-2007[a]	1996-2007[g]	1.8	1.7
5	Petroleum refinery production	1998-2007[c]	2003-2007[h]	2.1	3.3
6	Mining production	1998-2007[c]	2003-2007[h]	2.0	1.1
7	Aviation landing and take off	1998-2007[a]	2003-2007[i]	2.4	1.1
9	GDP in forestry sector	1998-2007[a]	-	0.7	-
10	Forestry area	-	1992-2001[e]	-	0.9
11	Energy consumption in power generation	2000-2007[c]	1988-2007[h]	1.8	2.1
12	Energy consumption in industrial sector	2000-2007[c]	1988-2007[h]	1.9	2.0
13	Total GDP	2000-2007(all other SEA countries)[d]		2.2	

Note: only the 1999-2007 data period was used for the regression analysis. The data available before that was not incorporated because of the drastic economic recession in SEA during 1997-1998.

Data sources:

[a] National Bureau of Statistics (BPS, 2008). Indonesia in figure 2008.

[b] Department of Land Transportation (DLT, 2008). Transportation Statistics 2008.

[c] Ministry of Energy and Mineral Resources (MEMR, 2008). Key Indicator of Indonesia Energy and Mineral Resources 2008.

[d] The World Bank (WB, 2008). http://data.worldbank.org/indicator/NY.GDP.PCAP.KD.ZG. Population weighted GDP from other SEA countries and China for the period of 2000-2007 was collected to project to 2030. The GDP growth factor expressed as the ratio of 2030/2007 population weighted GDP was calculated and was used to project emissions for other SEA countries and Southern part of China.

[e] Thailand National Statistics Office (NSO, 2008).

[f] Ministry of Transportation (DLT, 2008). Transportation Statistics. Department of Land Transport (DLT) (2008).

[g] Office of Agricultural Economics (OAE, 2008). Agricultural Statistics of Thailand 2008.

[h] Energy Policy and Planning Office (EPPO, 2008). Statistics database.

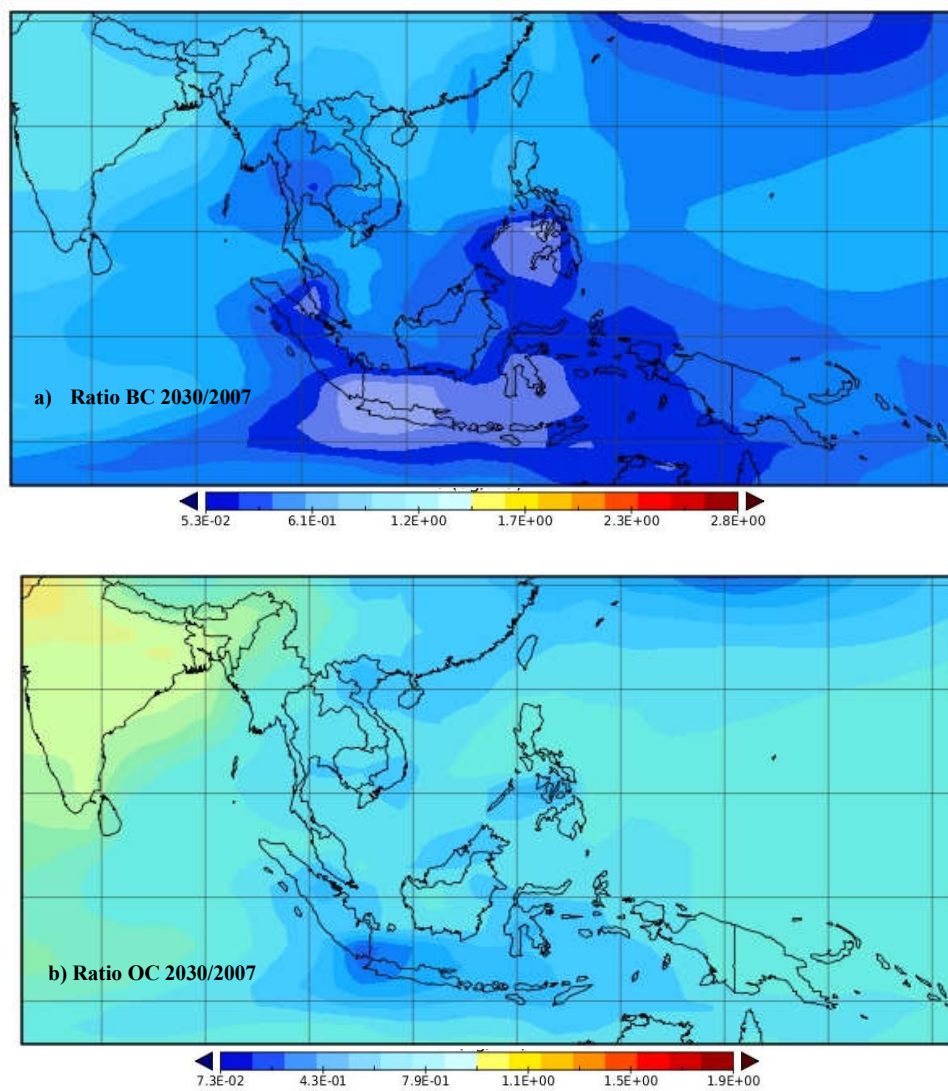[i] Department of Civil Aviation (DCA, 2008). Statistics report.

a) Ratio BC 2030/2007

| 5.3E-02 | 6.1E-01 | 1.2E+00 | 1.7E+00 | 2.3E+00 | 2.8E+00 |

b) Ratio OC 2030/2007
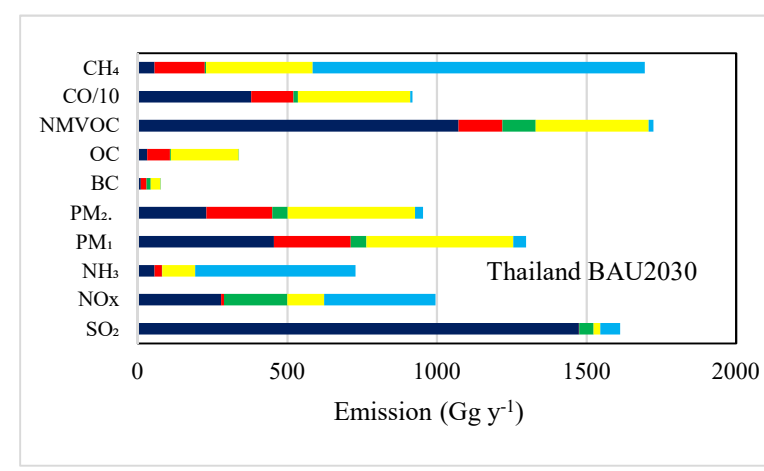
| 7.3E-02 | 4.3E-01 | 7.9E-01 | 1.1E+00 | 1.5E+00 | 1.9E+00 |

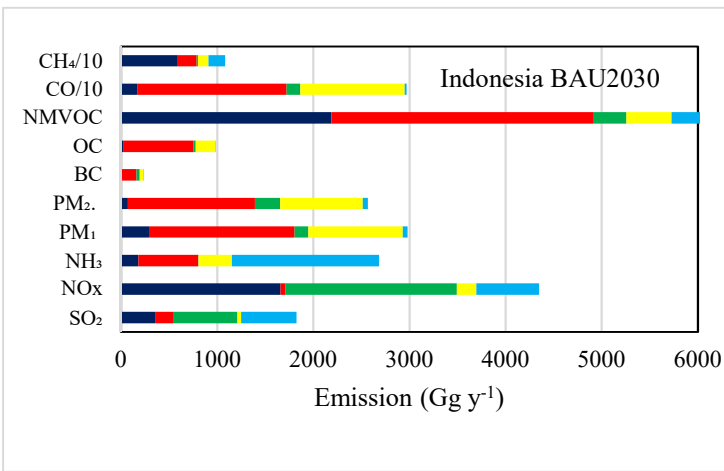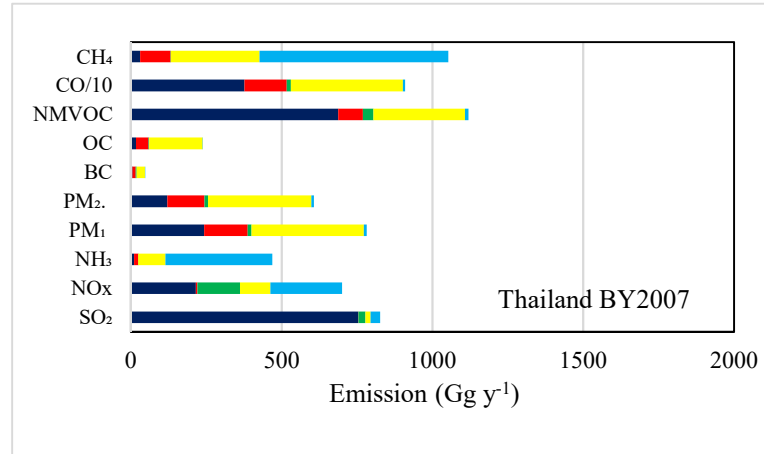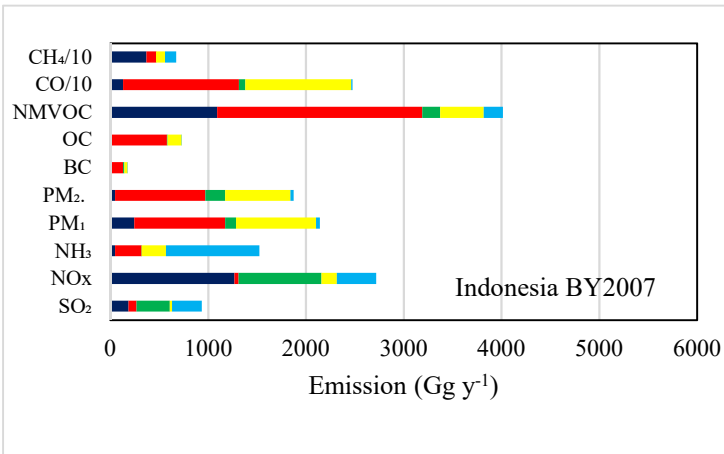**Figure S1: Monthly average concentrations of BC and OC obtained from global LMDZ/INCA simulation for 2007 and 2030 and the constructed 2030/2007 ratios for both species (Data from Dr Didier Hauglustaine, through personal communication)**
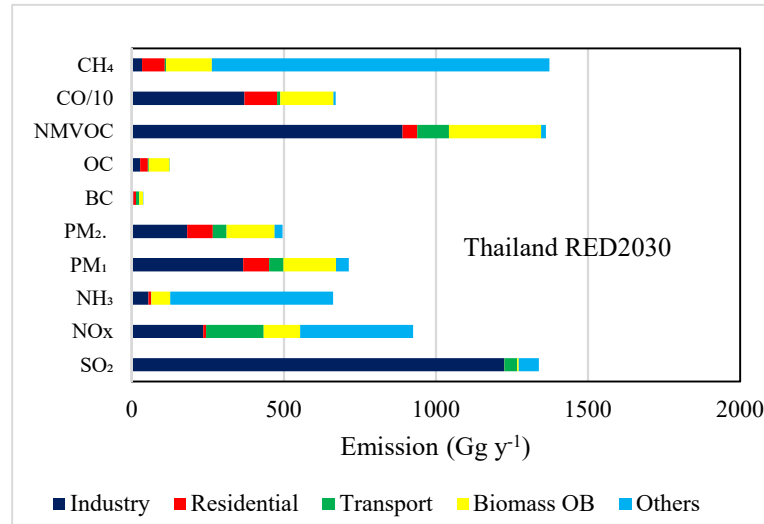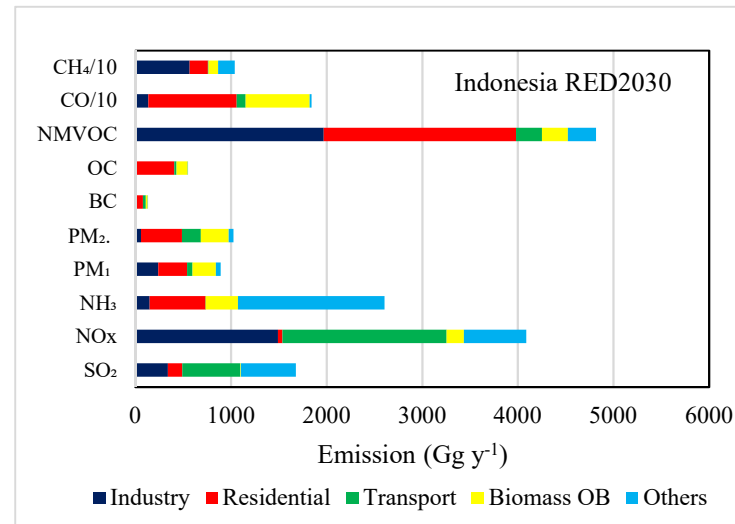
a) Indonesia

b) Thailand

Figure S2: Sectoral emissions of key species in BY2007, BAU2030 and RED2030 scenarios for Indonesia and Thailand