Supporting Information for

Burden of disease from rising coal-fired power plant emissions in Southeast Asia

Shannon N. Koplitz[1], Daniel J. Jacob[2], Melissa P. Sulprizio[2], Lauri Myllyvirta[3], and Colleen Reid[4]

[1]Department of Earth and Planetary Sciences, Harvard University, Cambridge, MA, 02138 USA
[2]John A. Paulson School of Engineering and Applied Sciences, Harvard University, Cambridge, MA, 02138 USA
[3]Greenpeace International, 1066 AZ Amsterdam, the Netherlands
[4]Department of Geography, University of Colorado, Boulder, CO, 80309 USA

Total number of pages: 10
Total number of tables: 4
Total number of figures: 5

List of Contents

Tables

Figures

Table S1. Relative risk (RR) factors by cause of death. See references given in the Methods section.

Cause of death	Low	Central	High
COPD	1.077	1.128	1.182
Stroke	1.077	1.128	1.182
IHD	1.177	1.287	1.407
Lung cancer	1.057	1.142	1.234
Other cardiovascular	1.077	1.128	1.182
Lower respiratory infection	1.03	1.12	1.3
Other respiratory	1.077	1.128	1.182
Respiratory disease (ozone only)	1.01	1.04	1.067

Table S2. Coal-related changes in population-weighted $PM_{2.5}$ and ozone by country.

Country	2011-no coal $PM_{2.5}$ ($\mu g \ m^{-3}$)	2011 – no coal O_3 (ppb)	2030 -2011 $PM_{2.5}$ ($\mu g \ m^{-3}$)	2030 - 2011 O_3 (ppb)
Indonesia	0.67	1.98	1.03	2.40
Vietnam	1.24	1.88	3.05	4.24
China	0.03	0.08	0.05	0.13
Myanmar	0.08	0.28	0.77	2.21
Thailand	0.36	0.68	0.55	1.60
Japan	0.13	0.39	0.03	0.06
Philippines	0.10	0.61	0.20	1.43
Malaysia	0.36	1.53	0.21	1.21
South Korea	0.34	0.05	0.21	-0.01
Taiwan	0.16	0.34	0.08	0.20

Table S3. PM$_{2.5}$-related premature mortality estimates for 2011 by cause. For comparison, estimates using concentration-response relationships from Burnett et al.[1] are shown in parentheses.

Country	Stroke	IHD	COPD	LC	Total
Indonesia	2697 (3071)	2330 (1128)	383 (189)	324 (165)	5734 (4553)
Vietnam	1625 (720)	1029 (124)	345 (85)	358 (107)	3357 (1036)
China	774 (298)	890 (92)	419 (102)	254 (69)	2337 (561)
Myanmar	62 (89)	67 (63)	21 (14)	8 (6)	158 (172)
Thailand	228 (246)	599 (163)	97 (31)	101 (47)	1025 (487)
Japan	241 (245)	391 (157)	48 (21)	109 (68)	789 (491)
Philippines	79 (88)	225 (188)	16 (7)	19 (12)	339 (295)
Malaysia	64 (82)	253 (163)	26 (11)	19 (11)	362 (267)
South Korea	161 (75)	160 (11)	29 (11)	61 (25)	411 (122)
Taiwan	32 (36)	50 (15)	12 (6)	15 (6)	109 (63)
Rest of Asia	100 (73)	227 (56)	80 (32)	24 (10)	431 (171)
Total	6063 (5023)	6221 (2160)	1476 (509)	1292 (526)	15052 (8218)

Table S4. Excess deaths and excess deaths per capita due to coal plant emissions in 2011 and 2030.

Country	2011 deaths	2011 deaths / million people	2030 deaths	2030 deaths / million people
Indonesia	7483	30.3	25052	85.4
Vietnam	4252	46.8	19223	188.8
China	3153	2.3	8869	6.1
Myanmar	228	4.3	4027	68.6
Thailand	1334	20.0	3930	58.2
Japan	1054	8.3	1241	10.3
Philippines	471	4.9	2009	15.7
Malaysia	487	16.7	956	25.9
South Korea	491	10.0	788	15.1
Taiwan	142	6.1	214	9.1
Rest of Asia	787	0.5	3353	1.7
Total	19882	5.2	69662	16.1

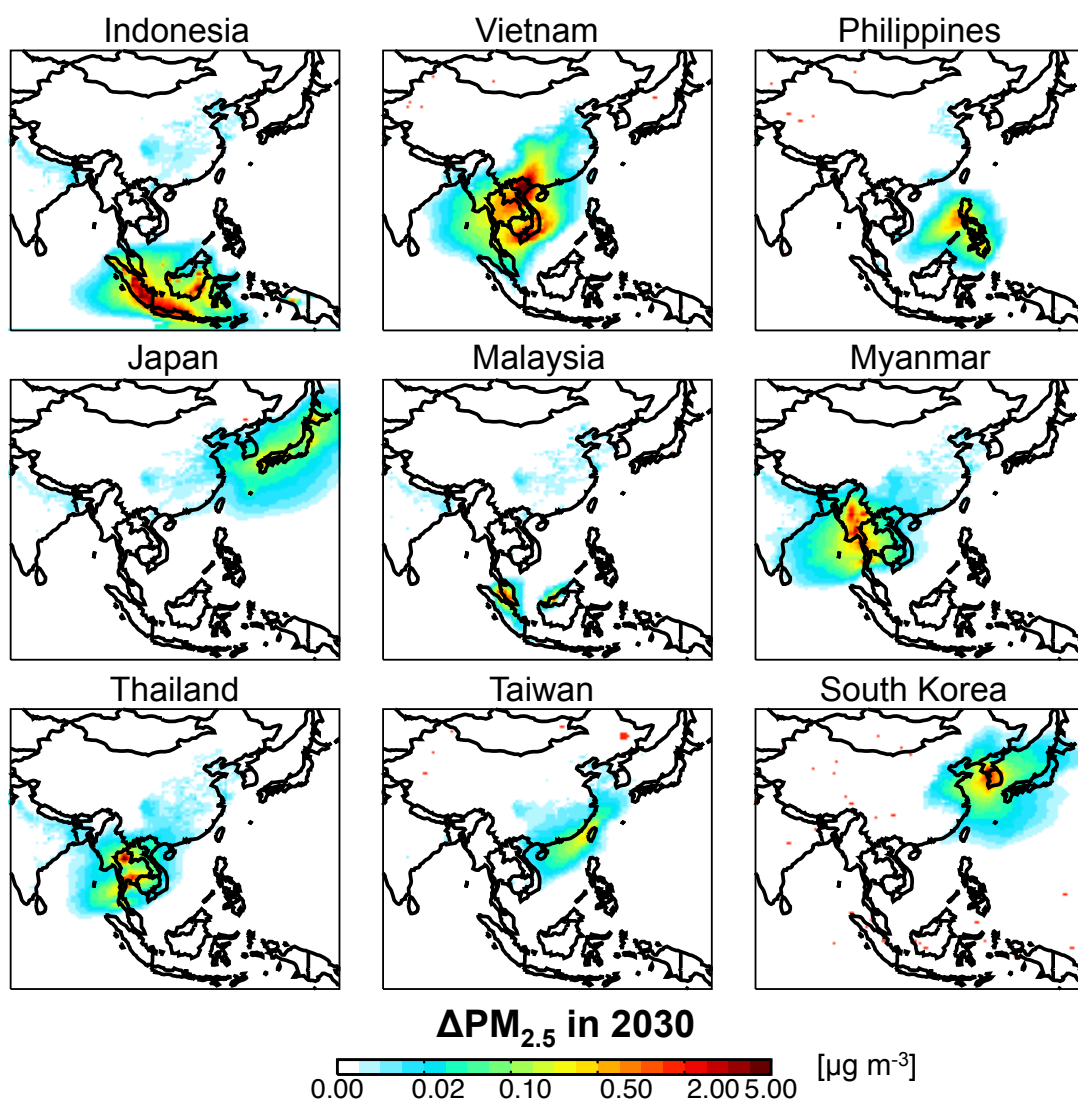**Figure S1.** Projected increases (Δ) in surface PM$_{2.5}$ in Southeast Asia due to coal in 2030, as determined by difference between the regional simulation with 2030 emissions and a simulation with zero coal emissions in each country in Table 1 (except for Laos and Cambodia where coal emissions were less than 0.01 Tg a^{-1} for all species). Emissions in other countries are unchanged.
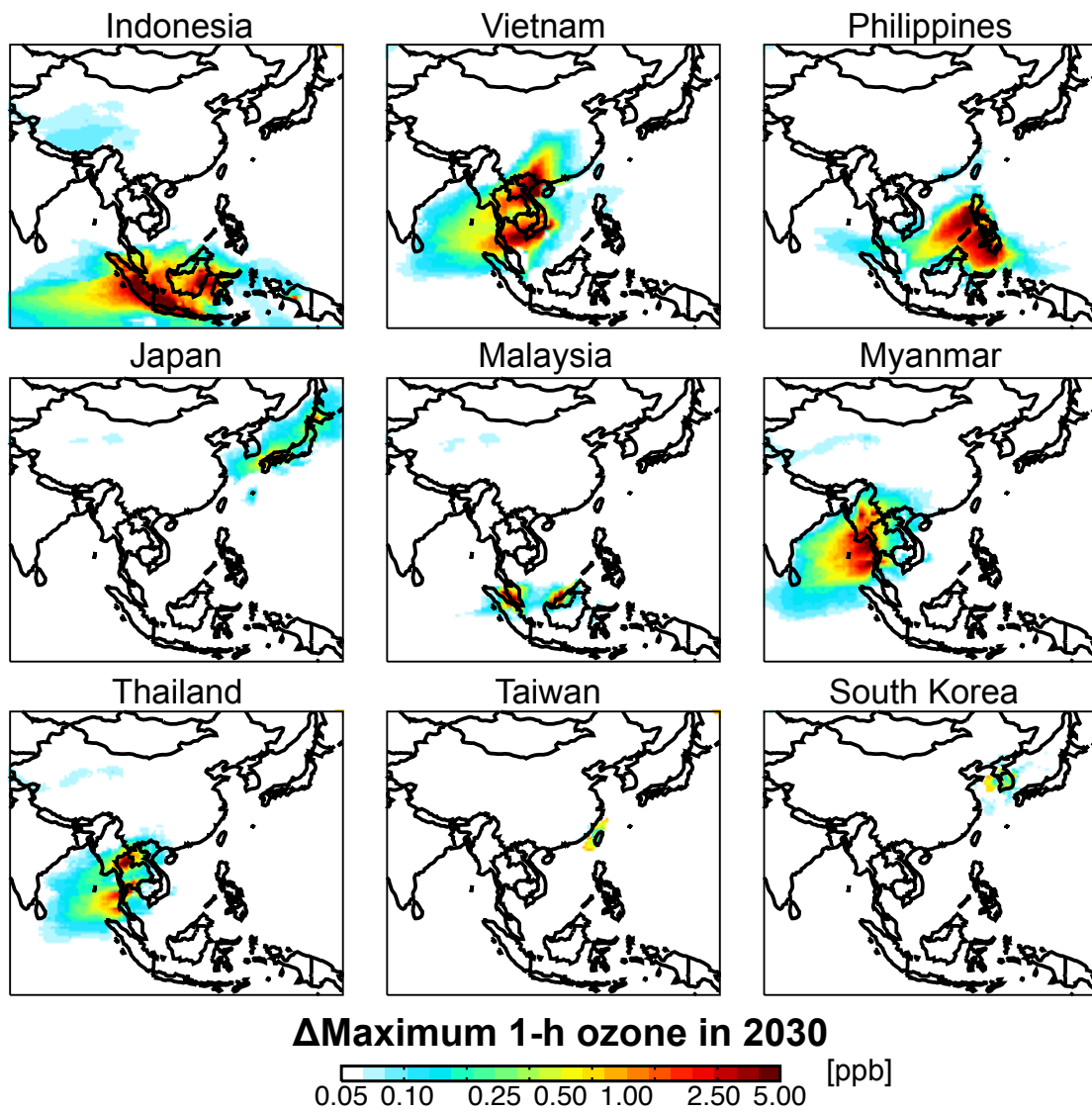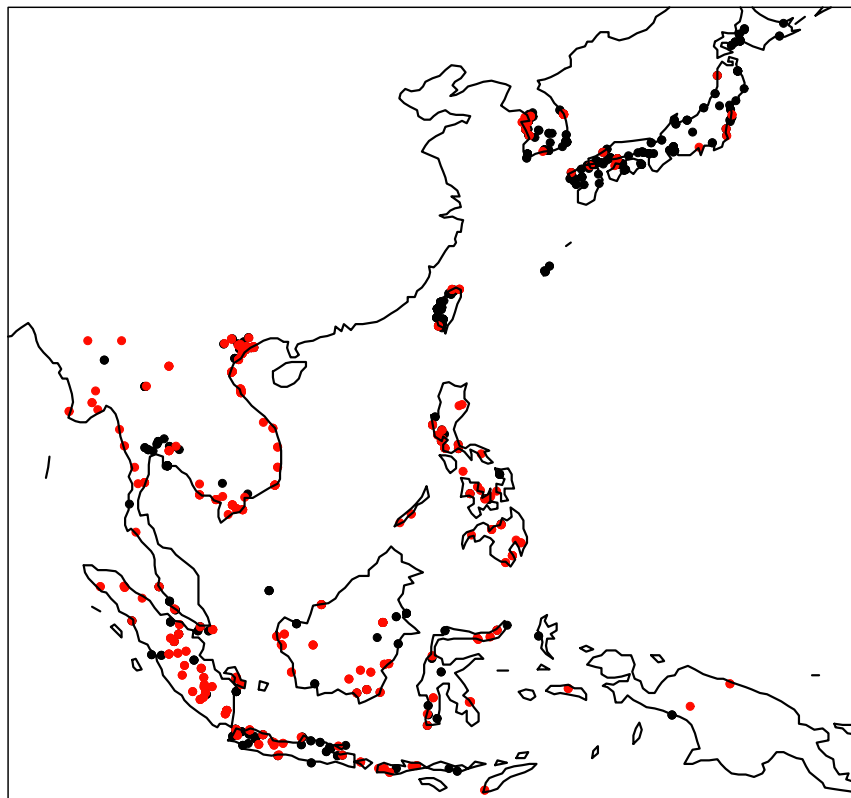
ΔMaximum 1-h ozone in 2030 [ppb]

Figure S3. Power plant locations in 2011 and projected for 2030 in Southeast Asia outside of China and India. Plants operating in 2011 are shown in black. Plants planned for development by 2030 are shown in red.
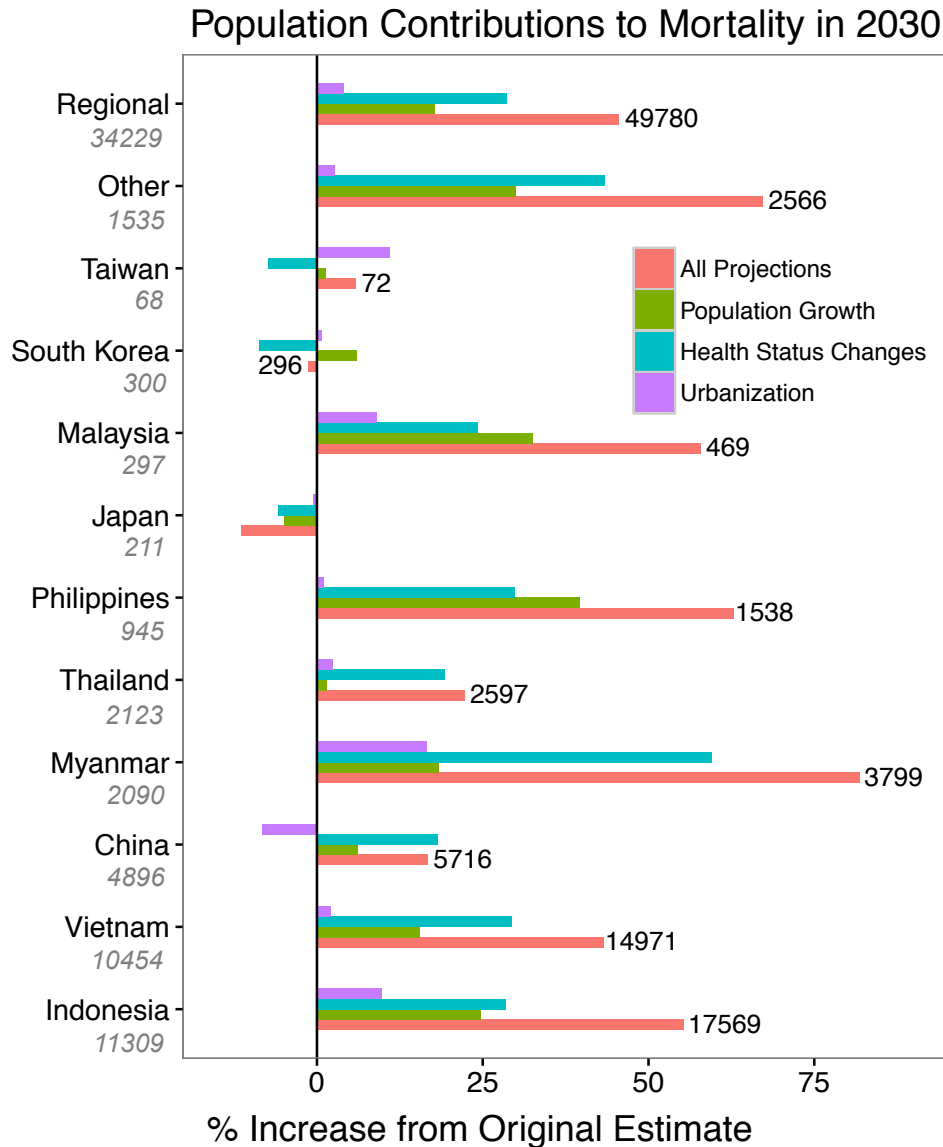
Figure S4. Percent contributions of population changes to coal-related premature mortality increases between 2011 and 2030 by country. Values shown by the colored bars represent the percent change in mortality due to including each population factor relative to the baseline mortality estimate using the 2030 pollution change (2030 simulation – 2011 simulation) and the original 2011 population estimates. The combined contribution from all factors for each country is shown in pink. Contributions from population number growth are shown in green, changes in baseline health status (incidence of disease, obesity, etc) are shown in blue, and spatial changes driven by urbanization are shown in purple. See "Future health impact projections" section for descriptions of datasets used for each factor. The original estimates for the increase in mortality between 2011 and 2030 in each country before including the population projections are shown in grey under the corresponding country label. The final estimates after including all population factors (i.e. the values used in the estimates reported in the main text) are shown at the end of the pink bars.
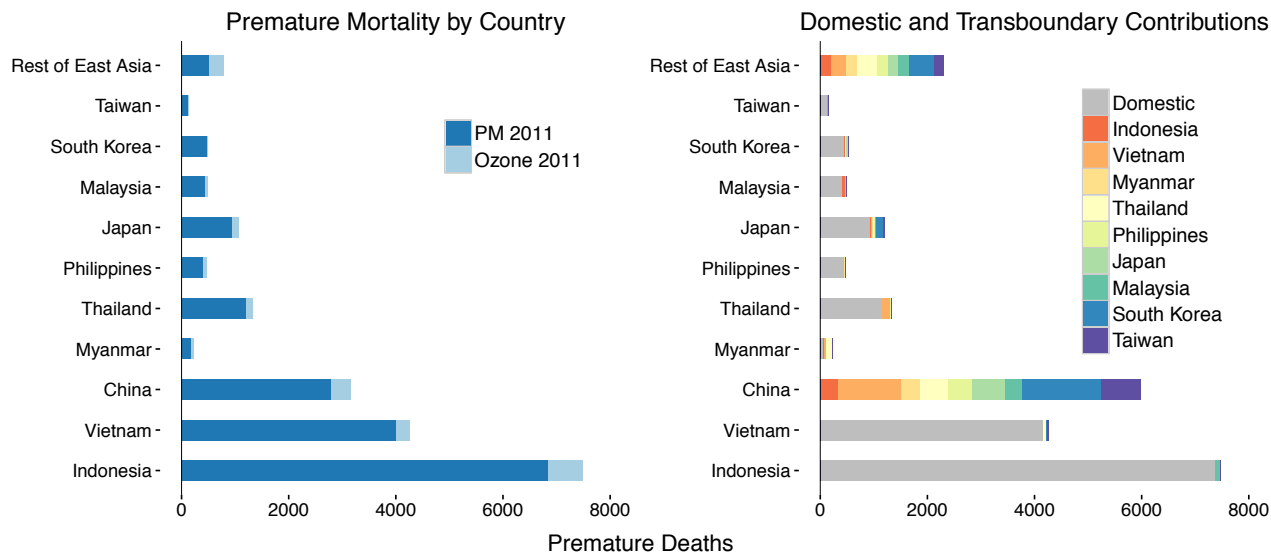
Figure S5. Coal-related mortality in 2011 due to emissions in Southeast Asia (countries in Table 1). The left panel shows the premature deaths in individual countries. Deaths due to $PM_{2.5}$ and ozone are shown separately. The right panel shows the 2011 coal-related mortality in each country broken down by contributions from domestic and transboundary sources. As computed here, mortality in China and Rest of East Asia (not included in Table 1) is solely from transboundary pollution. The mortality totals in the right panel are the sums of the contributions from simulations with vs. without coal emissions for the individual countries in Table 1; because of chemical and CRF non-linearities, they may be greater than the mortality totals in the left panels.

REFERENCES

(1)   Burnett, R. T.; et al. An integrated risk function for estimating the Global Burden of Disease attributable to ambient fine particulate matter exposure. *Environ. Health Perspect.* **2014**, *122*, 397-403. DOI: 10.14288/1.0220726