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Supporting Information for

Seeking natural capital projects: Forest fires, haze and early-life exposure in Indonesia

Jie-Sheng Tan-Soo and Subhrendu K Pattanayak

Address correspondence to: Subhrendu Pattanayak
(subhrendu.pattanayak@duke.edu)

This PDF file includes:

Figs. S1 to S4
Tables S1 to S6

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Figure S1: One-way sensitivity analysis of societal net present values for the baseline scenario of using fires to clear land

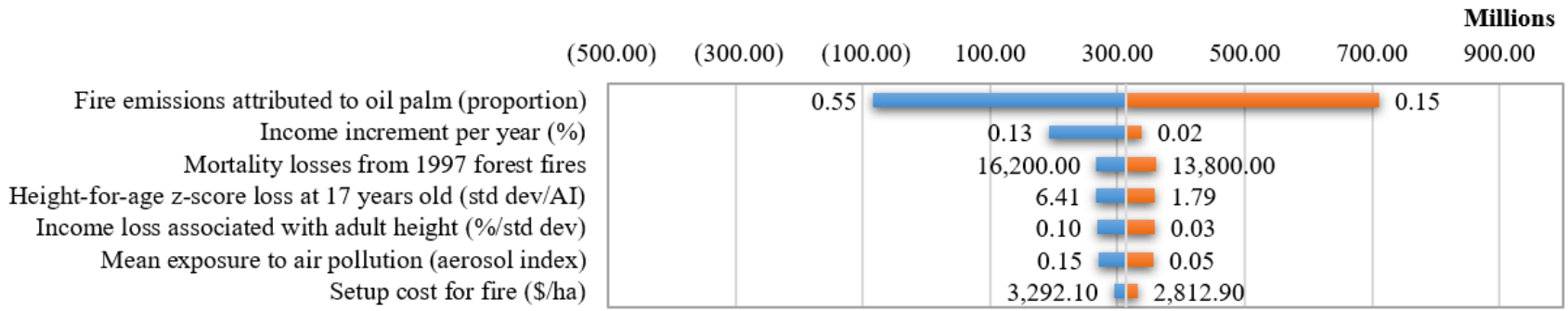

Figure S2: Cumulative distribution of impact of mechanical land clearing on firm's profits

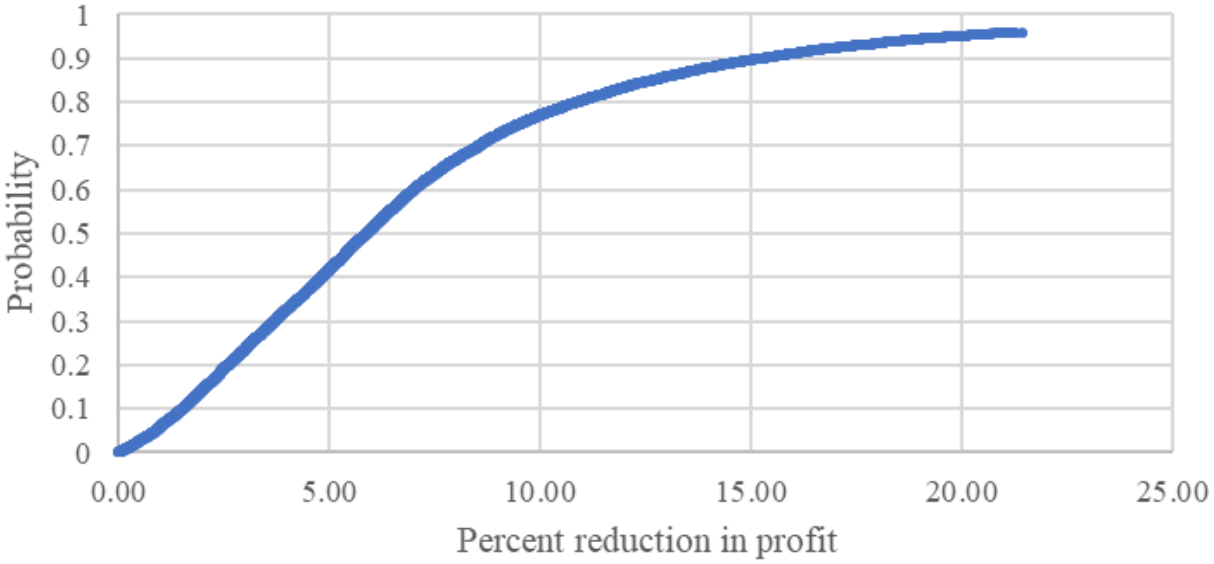

Figure S3: One-way sensitivity analysis of improvements in societal net present value for a credibly enforced fire ban policy against baseline scenario

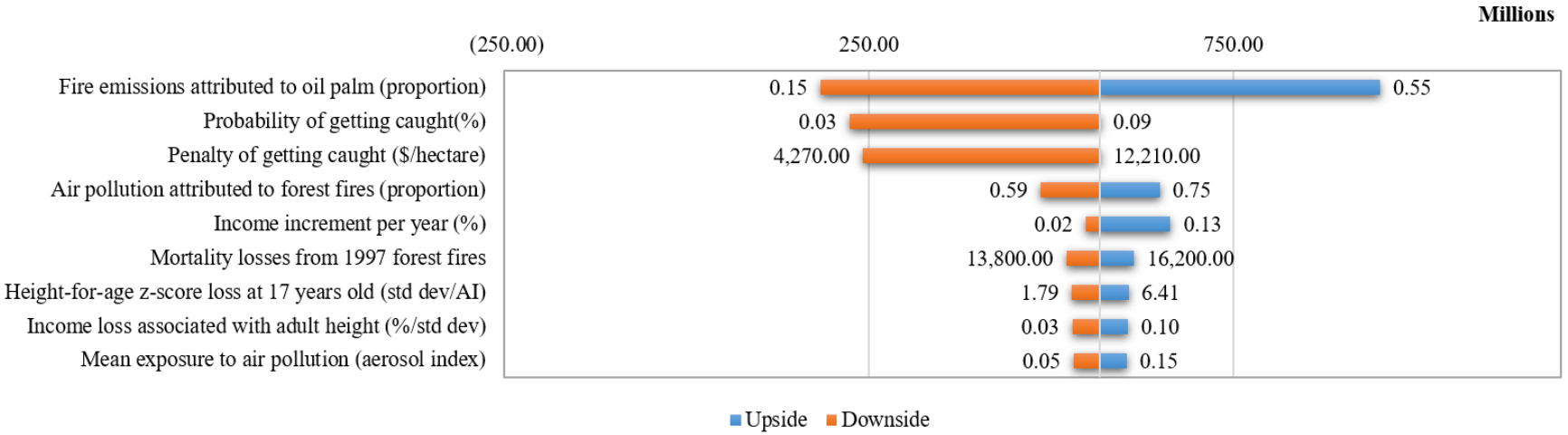

Figure S4: One-way sensitivity analysis of improvements in societal net present value for a fire suppression policy against baseline scenario

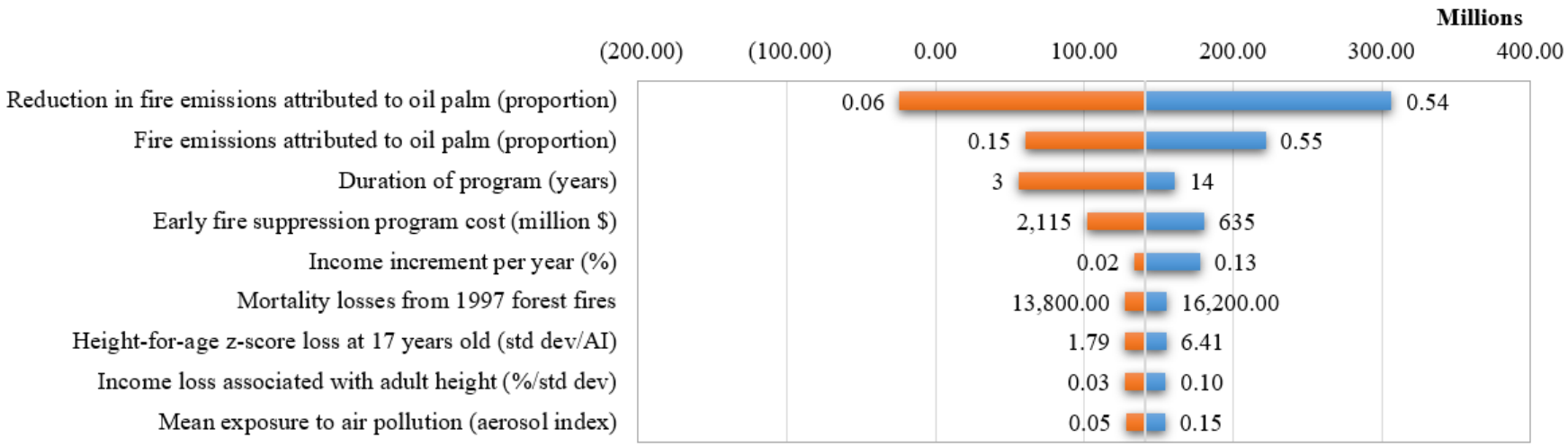

Table S1: Descriptive statistics

	Variable	Obs	Mean	Std Dev	Min	Max
Outcomes	Height-for-age z-score in second wave (year 2000)	564	-1.79	1.24	-4.71	2.41
	Height-for-age z-score in third wave (year 2007)	558	-1.58	1.11	-4.08	2.2
	Height-for-age z-score in fourth wave (year 2014)	558	-1.69	0.90	-4.08	1.58
Environmental Covariates	Average aerosol index exposure from August to October 1997	564	0.1	0.04	0	0.3
	Average aerosol index exposure from August to October 1997 (prenatal exposure only)	564	0.08	0.05	0	0.3
	Average aerosol index exposure from August to October 1997 (postnatal exposure only)	564	0.02	0.04	0	0.19
	Precipitation (mm)	564	21.36	16.55	0.63	138.32
	Temperature anomaly (ºC)	564	-0.2	0.26	-0.82	0.91
	Aerosol index 1998	564	0.07	0.01	0.00	0.10
	Aerosol index 1999	564	0.07	0.01	0.05	0.13
HH covariates	Improved sanitation in 1997 (1 = yes; 0 = no)	564	0.72	0.45	0	1
	Biomass fuel in 1997 (1 = yes; 0 = no)	564	0.46	0.5	0	1
Parental covariates	Father's height (cm)	564	160.57	12.4	15.6	181
	Mother's height (cm)	564	150.35	7.79	15.4	166.4
	Father at least high school (1 = yes; 0 = no)	564	0.26	0.44	0	1
	Mother at least high school (1 = yes; 0 = no)	564	0.22	0.41	0	1

Table S2: Results for all estimation models

VARIABLES	(1) Main results	(2) Main results	(3) Later years	(4) Later years	(5) Outdoor workers	(6) Outdoor workers	(7) Placebo	(8) Placebo
	Height-for-age z-scores							
Aerosol Index (AI)	-4.13**		-4.03**		-4.10**		2.61	
AI(pre-natal)		-4.34**		-4.24**		-4.59**		-1.96
AI(post-natal)		-3.66		-3.54		-2.94		5.60
AI*proportion of outdoor workers					-0.14			
AI(pre-natal)*proportion of outdoor workers						0.14		
AI(post-natal)*proportion of outdoor workers						-1.52		
AI in 1998			0.36	0.00				
AI in 1999			6.08	6.23				
AI*year2000	-0.15		-0.21		-0.34		-6.67*	
AI*year 2007	-1.28*		-1.21*		-1.50**		-4.80**	
AI(pre-natal)*year2000		-0.06		-0.12		-0.03		-7.71*
AI(pre-natal)*year2007		-1.33*		-1.26*		-1.45**		-6.28***
AI(post-natal)*year2000		-0.59		-0.69		-1.95		-4.55
AI(post-natal)*year2007		-1.02		-0.92		-1.80*		-1.74
AI in 1998*year2000			2.85	2.78				
AI in 1998*year2007			4.87	5.03				
AI in 1999*year2000			-0.33	-0.28				
AI in 1999*year2007			-3.02	-3.10				
AI*proportion of outdoor workers*year2000					-2.65*			
AI*proportion of outdoor workers*year2007					-3.00***			
AI(pre-natal)*proportion of outdoor workers*year2000						-4.31**		

AI(pre-natal)*proportion of outdoor workers*year2007						-3.77***		
AI(post-natal)*proportion of outdoor workers*year2000						3.91**		
AI(post-natal)*proportion of outdoor workers*year2007						0.11		
Year 2000 (binary variable)	-0.08	-0.08	-0.62*	-0.62*	-0.01	0.00	0.04	0.05
Year 2007 (binary variable)	0.24***	0.24***	0.47***	0.47***	0.32***	0.32***	0.21***	0.22**
Observations	1,680	1,680	1,680	1,680	1,680	1,680	1,680	1,680
R-squared	0.39	0.39	0.39	0.39	0.39	0.39	0.38	0.39

Controls include father's and mother's height, father's and mother's educational level, household usage of improved sanitation and biomass fuel at early-life, and rainfall and temperature for same time period as AI.
District fixed effects and birth-year-by-birth-month fixed effects included in all models
Standard errors are clustered multi-way at district level and birth-year-by-birth-month level
*** p<0.01, ** p<0.05, * p<0.1

Table S3: Distribution of cohort according to birth-years and -months

Birth Year	Month	Number(%)	Birth Year	Month	Number(%)
1997	March	28(5)	1998	January	27(5)
	April	31(5)		February	26(5)
	May	34(6)		March	26(5)
	June	27(5)		April	31(5)
	July	33(6)		May	35(6)
	August	34(6)		June	38(7)
	September	28(5)		July	35(6)
	October	30(5)		August	34(6)
	November	31(5)			
	December	36(6)			

Table S4: Results for household consumption mechanism check

VARIABLES	Household consumption per capita (rupiahs)
Survey administered after 1997 fires (1 = yes, 0 = no)	1,306.435
	(0.713)
Urban	-1,015.473
	(0.551)
Constant	12,988.647***
	(0.000)
Observations	445
District fixed effects	Y
R-squared	0.003

Standard errors clustered at district level, p-values in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table S5: List of parameters used in cost-benefit analysis

Parameter	Symbol	Base Value	Min	Max	Distribution	
Value of statistical life	VSL	US$158,400	79,200	250,800	Uni	OECD (2012); US EPA, World Bank Statistical Database
Air pollution attributed to forest fires	AP_{FF}	0.6	0.57	0.77		Authors' calculations
Forest fires emissions attributed to oil palm plantations	FFE_{OP}	0.30	0.1	0.6		Marlier et al. (2015)
Mortality losses from 1997 forest fires	$Mort$	15,000	13,500	16,500		Tacconi (2016)
Plantation setup cost for fire-clearing ($/ha)	SP_f	3,053	2,753	3,352		Butler et al (2009), Rotheli, 2007), authors' estimates
Plantation setup cost for mechanical-clearing ($/ha)	SP_m	3,816	3,441	4,190		Butler et al (2009), Rotheli, 2007),
Indonesians in prenatal stage during Aug-Oct 1997	$Born$	1.1 million	N.A.			Indonesian 2010 census
Average blue-collar annual wage	$Wage$	US$860	774	946	Uni	Indonesian Statistical Department (2014 figures)
Annual wage increment	Inc	2%	0%	15%		Indonesian Statistical Department
Mechanical cost of land clearing	$Clear_{Mech}$	US$595/hectare	199	990		Tacconi (2007); Simorangkir (2007); Guyon & Simorangkir (2002)
Fire cost of land clearing	$Clear_{Fire}$	US$200/hectare	82	320		Guyon & Simorangkir (2002); Simorangkir (2007)
Ecological cost of mechanical land clearing	Eco	US$57/hectare	33	80		Medjibe & Putz (2012)
Impact of AI on HAZ at 17 years old	HAZ_{AI}	4.1 std dev/AI	4.1(1.8)^		Normal	This study
Mean exposure to AI at early-life	AI	0.1	0.1(0.04)^			
Income loss associated with adult HAZ	$Wage_{HAZ}$	6%/std dev	2%	11%	Uni	Victora et al. (2008), Schultz (2002)
Oil palm plantations from 1997 fires	OP	100,000 hectares	N.A.			Wicke et al. (2011)
Setup period	$years$	8 years				Butler, Koh, and Ghazoul (2009)
Oil palm operating costs and revenue	OP_{Cost}	Various	High- and low-yield scenarios in cited study		Uni	Butler, Koh, and Ghazoul (2009)
	OP_{Rev}					
Social discount rate (%)	DR	8%	5%	10%		Irawan & Tacconi (2016); ADB (2013)
Cost of early-fire detection system (million $)	EF	US$540 million	450	2300		Indonesian government
Annual cost of enforcement of fire-ban (million $)	FB	US$29 million	20	50		Indonesia government
Shelf-life of early-fire detection system (years)	$life$	7 years	2	15		Authors' estimates
Impact of haze pollution on tourism ($)	$tour$	US$114 million	88	140		

Impact of haze pollution on transportation ($)	tp	US$33 million	23	42		Glover & Jessup (1999); BAPENDAS-ADB (1999); Adapated from Tacconi (2003)
Penalties for firms caught using fire ($/hectare)	pen	US$15,000/hectare	300	50,000		Authors' estimates
Probability of getting caught for using fires	cgt	0.05	0	0.3		Recent court judgements
Risk averseness of firms in response to fire enforcement	$risk$	1 (risk neutral)	0.1 (risk adverse)	3 (risk taking)	Uni	Authors' estimates

^ Displayed as mean and standard deviation in parentheses for parameters in normal distribution

Table S6: Equations used in cost-benefit analysis

Private firm profits	Revenue of oil-palm plantations – Costs of plantations (land clearing, set-up, maintenance)
Net social benefits	Avoided health costs (mortality, morbidity) + avoided non-health costs (tourism, transportation) – private firm profits
Net social benefits (suppression policy)	Avoided health costs (mortality, morbidity) + avoided non-health costs (tourism, transportation) – private firm profits – Program costs
Net social benefits (enforcement policy)	Avoided health costs (mortality, morbidity) + avoided non-health costs (tourism, transportation) – private firm profits – Program costs
Individual components (Costs/benefits)	**Equations**
Land clearing cost (mechanical)	$(Clear_{Mech} + Eco) \cdot OP$
Land clearing cost (fire)	$(Clear_{Fire}) \cdot OP$
Setup cost (mechanical)	$\frac{OP}{years} \cdot SP_m \left[\left(1 - \left(\frac{1}{1-DR}\right)\right) \Big/ \left(1 - \left(\frac{1}{1-DR}\right)^{years}\right) \right]$
Setup cost (fire)	$\frac{OP}{years} \cdot SP_f \left[\left(1 - \left(\frac{1}{1-DR}\right)\right) \Big/ \left(1 - \left(\frac{1}{1-DR}\right)^{years}\right) \right]$
Mortality cost	$AP_{FF} \cdot FFE_{OP} \cdot VSL \cdot Mort$
Loss-of-income	$AP_{FF} \cdot FFE_{OP} \cdot Born \cdot HAZ_{AI} \cdot AI \cdot \left[\left(\sum_{t=21}^{35} \frac{Wage \cdot (1+Inc)^{t-21}}{(1+DR)^t} \right) + \left(\sum_{t=36}^{58} \frac{Wage \cdot (1+Inc)^{15}}{(1+DR)^t} \right) \right]$
Tourism	$AP_{FF} \cdot FFE_{OP} \cdot Tour$
Transportation	$AP_{FF} \cdot FFE_{OP} \cdot Tp$
Annual cost of early-fire detection	$EF \cdot \left[\left(1 - \left(\frac{1}{1-DR}\right)\right) \Big/ \left(1 - \left(\frac{1}{1-DR}\right)^{life}\right) \right]$
Proportion reduction in using fires in response to enforcement	$1 - risk^{\frac{(cgt*pen)}{(Clear_{Mech}+Eco-Clear_{Fire})}} \cdot \left(1 - \frac{(cgt*pen)}{(Clear_{Mech}+Eco-Clear_{Fire})}\right)$