The multifaceted relationship between environmental risks and poverty: new insights from Vietnam

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ONLINE APPENDIX

Table A.1. Summary statistics of consumption, environmental risks and control variables, 2010, 2012, 2014

Variable	Description	Type	Pooled Cross-Section			Panel Dataset	
			2010	2012	2014	2010-2012	2012-2014
Number of households			9,398	9,399	9,399	4,134	3,963
Consumption	Total per capita expenditure in 2011 PPP	Household - Time variant	2,965	3,188	3,395	258	236
Environmental risks							
Air pollution	Area-weighted mean PM2.5 concentration 2000-10 in micrograms per m3	Commune - Fixed	17.0	17.1	17.0	17.3	17.3
Tree cover loss	Share of forest area affected by tree cover loss in 2001-10	Commune - Fixed	1.5	1.5	1.5	1.6	1.5
Land degradation	Share of land area affected by significant biomass decline	Commune - Fixed	17.9	17.8	17.9	17.2	17.7
Slope	Area-weighted average of slope categories: 1=least steep - 8=most steep	Commune - Fixed	3.37	3.38	3.37	3.41	3.39
Rainfall variability	Standard deviation of monthly rainfall 1981-2010	Commune - Fixed	55.2	54.6	55.8	54.9	56.4
Temperature variability	Standard deviation of mean annual temperature 1981-2010	Commune - Fixed	0.72	0.74	0.74	0.74	0.74
Flood hazard	Share of area at risk of a flood event with a 25 year return period	Commune - Fixed	32.1	32.0	32.0	31.8	31.8
Drought hazard	Number of months to overcome the maximum accumulated deficit volume	Commune - Fixed	1.03	1.03	1.03	1.04	1.03
Control variables							
Current rainfall	Average of monthly rainfall in survey year in mm	Commune- Time variant	142	183	169	41.3	-14.0
Current temperature	Annual average of monthly mean temperature in survey year in Celsius degree	Commune- Time variant	26.0	25.5	25.2	-0.58	-0.13
Long-term rainfall	Mean of monthly rainfall in last 30 years	Commune - Fixed	157	156	158	156	158
Long-term temperature	Mean of monthly temperature mean in last 30 years	Commune - Fixed	25.4	25.4	25.5	25.4	25.4
Distance city	Distance from commune to next main city	Commune - Fixed	29.9	29.9	29.9	30.2	30.0
Distance road	Distance from commune to next road	Commune - Fixed	3.04	3.04	3.03	3.07	3.07
Area agriculture	Area for agricultural activities household has access to	Household - Time variant	3.86	3.99	3.93	0.18	0.09
Area forest	Forest area household has access to	Household - Time variant	1.83	1.47	1.34	0.36	-0.08
Area water surface	Water surface area household has access to	Household - Time variant	0.38	0.34	0.35	-0.02	0.02
Workforce	Share of household members involved in income generating activities	Household - Time variant	0.79	0.78	0.79	0.00	0.01
Education	Average number of school years of household members	Household - Time variant	6.48	6.56	6.66	0.12	0.02
Age head	Age of household head in years	Household - Fixed	48.3	49.7	50.7	50.4	51.3
Female head	Dummy = 1 if household head is female	Household - Fixed	0.25	0.25	0.26	0.25	0.25
Minority	Dummy = 1 if household belongs to ethnic minority	Household - Fixed	0.17	0.17	0.17	0.18	0.17

Notes: The table indicates mean values for each year for the Pooled Cross-Section. For the Panel Dataset, mean differences between years are presented for time variant variables and mean values for fixed variables.

Sources: Authors' calculation based on socio-economic data from VHLSS 2010, 2012 and 2014 and environmental data from Brauer *et al.*, 2015, Hansen *et al.*, 2013, Vu *et al.*, 2014, Harmonized World Soil Database, Climate Research Unit, Bangalore *et al.*, 2016, and Winsemius *et al.*, 2015.

Table A.2. Number of poor people in 2010 across environmental risk categories at district level

Risk category	Air pollution	Tree cover loss	Land degradation	Slope	Rainfall Variability	Temperature Variability	Flood hazards	Drought hazards
Low	23,393	19,792	18,206	21,302	22,117	21,688	30,318	20,172
Medium	24,874	25,046	27,650	21,858	28,054	27,455	21,769	24,281
High	25,741	28,967	28,713	30,632	24,106	25,124	21,704	29,349
ANOVA								
F	1.08	16.99	28.63	22.27	7.09	6.56	19.82	16.94
Prob>F	0.3405	0.0000	0.0000	0.0000	0.0009	0.0015	0.0000	0.0000

Notes: The table shows the number of poor people across the three environmental risks categories as calculated for figure 1 and statistics from a one-way analysis-of-variance (ANOVA), which assess whether the difference in poverty rates across risk categories is statistically significant.

Sources: Authors' calculation based on poverty data from the VHLSS 2010 based on Lanjouw et al., 2013, and environmental data from Brauer *et al*., 2015, Hansen *et al*., 2013, Vu *et al*,. 2014, Harmonized World Soil Database, Climate Research Unit, Bangalore *et al*., 2016, Winsemius *et al*., 2015, and Geographic Information Science and Technology, 2015.

Table A.3. Environmental risks across socio-economic groups in 2014

	Air pollution	Treecover loss	Land degradation	Slope	Rainfall variability	Temperature variability	Flood hazards	Drought hazards
Non-minority	16.41	1.2	17.58	2.89	56.32	0.72	35.97	1.02
Minority	20.1	3.12	19.5	5.81	53.43	0.84	12.11	1.11
Pr(|T| > |t|)	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00
Non-poor (88%)	16.76	1.31	18.07	3.13	55.58	0.73	33.88	1.03
Poor (12%)	19.17	3.15	16.50	5.27	58.00	0.82	17.08	1.06
Pr(|T| > |t|)	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.05
T60 (60%)	16.34	1.20	18.28	3.01	54.82	0.72	33.33	1.01
B40 (40%)	18.02	1.98	17.35	3.89	57.36	0.77	30.16	1.07
Pr(|T| > |t|)	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00
Urban	15.73	0.79	20.86	3.08	53.86	0.72	24.50	0.97
Rural	17.56	1.82	16.66	3.49	56.67	0.75	35.20	1.06
Pr(|T| > |t|)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: The table indicates the mean value for the group and probability from two-sample t-test for difference between the two groups.
Sources: Authors' calculation based on socio-economic data from VHLSS 2014 and environmental data from Brauer *et al.*, 2015, Hansen *et al.*, 2013, Vu *et al.*, 2014, Harmonized World Soil Database, Climate Research Unit, Bangalore *et al.*, 2016, and Winsemius *et al.*, 2015.

Table A.4. Correlation coefficients between consumption in 2014 and environmental risk variables

	Air pollution	Treecover loss	Land degradation	Slope	Rainfall variability	Temperature variability	Flood hazards	Drought hazards
All Households	-0.04	-0.09	0.01	-0.15	-0.03	-0.07	-0.03	-0.09
Significance level	0.00	0.00	0.41	0.00	0.00	0.00	0.01	0.00
Rural Households	-0.07	-0.08	0.01	-0.22	-0.03	-0.14	0.12	-0.05
Significance level	0.00	0.00	0.53	0.00	0.01	0.00	0.00	0.00
Urban Households	0.06	-0.05	-0.03	-0.04	0.01	0.05	-0.10	-0.08
Significance level	0.00	0.01	0.14	0.04	0.68	0.01	0.00	0.00

Notes: The table shows the correlation coefficient between per-capita consumption and the environmental risk variables for all households and the rural and urban sub-sample.
Sources: Authors' calculation based on socio-economic data from VHLSS 2014 and environmental data from Brauer *et al*., 2015, Hansen *et al*., 2013, Vu *et al*., 2014, Harmonized World Soil Database, Climate Research Unit, Bangalore *et al*., 2016, and Winsemius *et al*., 2015.

Table A.5. The effect of environmental risks on consumption differences between 'Pooled' households in 2010, 2012 and 2014

	Dependent variable: Ln of per-capita expenditure						
	All	Poor	B40	Rural	Rural 2014	Urban	Urban 2014
Air pollution	0.000511	0.00176	**0.00255****	**0.00425*****	0.00220	-0.00178	-0.00315
	(0.32)	(1.01)	(2.18)	(2.60)	(1.14)	(-0.55)	(-0.81)
Tree cover loss	-0.00179	0.00229	-0.00125	0.00132	-0.00248	-0.00705	-0.00500
	(-1.18)	(1.60)	(-1.10)	(0.88)	(-1.37)	(-1.35)	(-0.74)
Land degradation	**0.000300***	-0.000256	0.000171	0.000108	0.000197	-0.0000844	-0.00000728
	(1.87)	(-1.27)	(1.26)	(0.55)	(0.81)	(-0.33)	(-0.02)
Slope	**-0.0213*****	**-0.0148****	**-0.0102****	**-0.0101***	-0.00389	-0.0164	-0.0117
	(-3.98)	(-2.32)	(-2.43)	(-1.71)	(-0.55)	(-1.58)	(-0.88)
Rainfall variability	**-0.00276*****	-0.00120	-0.000420	**-0.00281*****	**-0.00499*****	-0.000672	-0.000577
	(-4.48)	(-1.46)	(-0.75)	(-4.21)	(-4.73)	(-0.58)	(-0.33)
Temperature variability	**-0.265***	0.0382	**-0.212***	**-0.454*****	-0.0311	0.113	0.318
	(-1.88)	(0.22)	(-1.68)	(-2.98)	(-0.17)	(0.42)	(0.95)
Flood hazard	**-0.00144*****	-0.000202	0.00000600	0.000183	0.000441	**-0.00184*****	**-0.00201*****
	(-5.97)	(-0.74)	(0.04)	(0.67)	(1.43)	(-4.05)	(-3.96)
Drought hazard	**-0.0335*****	0.00353	**-0.0199****	**-0.0428*****	**-0.0379****	-0.0380	-0.0477
	(-2.67)	(0.26)	(-2.01)	(-3.17)	(-2.29)	(-1.59)	(-1.56)
<u>Control variables</u>							
Current rainfall	0.00121***	0.000473*	0.000247	0.00134***	0.00202***	0.0000388	0.000273
	(5.32)	(1.68)	(1.21)	(5.36)	(4.35)	(0.09)	(0.30)
Current temperature	0.0322	-0.0504**	-0.0400**	0.00195	0.00123	0.0381	0.120
	(1.55)	(-2.20)	(-2.10)	(0.09)	(0.03)	(0.97)	(1.45)
Long-term rainfall	-0.00191**	-0.000913	-0.00109*	-0.00181**	-0.000495	-0.000980	-0.00148
	(-2.37)	(-0.96)	(-1.66)	(-2.23)	(-0.49)	(-0.60)	(-0.68)
Long-term temperature	-0.0380*	0.0658***	0.0586***	0.00675	0.0270	-0.0321	-0.0998
	(-1.70)	(2.67)	(2.87)	(0.28)	(0.59)	(-0.78)	(-1.18)
Distance city	-0.00230***	-0.000223	-0.000399	-0.00101***	-0.000591	-0.00253***	-0.00220***
	(-7.79)	(-0.76)	(-1.63)	(-3.32)	(-1.51)	(-4.79)	(-3.32)
Distance road	-0.0110***	-0.00267**	-0.00462***	-0.00832***	-0.00785***	0.00329	0.00618
	(-6.29)	(-2.13)	(-4.01)	(-5.57)	(-4.12)	(0.62)	(1.05)
Area agriculture	0.00153***	0.00130*	0.00296***	0.00426***	0.00396***	-0.00169	-0.000953
	(2.93)	(1.67)	(5.52)	(7.95)	(5.68)	(-1.24)	(-0.61)
Area forest	-0.00000525	-0.000144**	-0.0000523	0.0000935	-0.000213	0.0000408	0.00505
	(-0.05)	(-2.46)	(-0.34)	(1.43)	(-0.49)	(0.01)	(0.88)
Area water surface	0.00467***	0.00170	0.00272***	0.00432***	0.00753***	0.00517**	0.00691
	(3.31)	(1.02)	(2.81)	(3.21)	(5.16)	(2.15)	(1.03)
Workforce	-0.115***	0.0910***	0.0735***	-0.00266	0.00383	-0.168***	-0.151***
	(-10.90)	(6.69)	(8.39)	(-0.24)	(0.25)	(-7.41)	(-4.56)
Education	0.103***	0.0243***	0.0375***	0.0860***	0.0849***	0.108***	0.105***
	(63.51)	(10.75)	(23.50)	(49.28)	(33.60)	(36.69)	(23.40)
Age head	0.000656**	0.000413	0.000315	0.000497	-0.0000227	0.000576	0.00140*
	(2.43)	(1.34)	(1.34)	(1.64)	(-0.05)	(1.12)	(1.91)
Female head	0.0854***	-0.00897	0.00950	0.0684***	0.0673***	0.0399***	0.0303
	(9.56)	(-0.69)	(1.11)	(6.36)	(4.37)	(2.74)	(1.47)
Minority	-0.409***	-0.0948***	-0.228***	-0.401***	-0.429***	-0.290***	-0.346***
	(-24.35)	(-6.11)	(-17.64)	(-22.16)	(-17.71)	(-7.87)	(-6.69)
Year 2012	0.0607***	-0.000678	0.0835***	0.0558***		0.0660**	
	(3.59)	(-0.03)	(5.33)	(3.02)		(2.13)	
Year 2014	0.150***	-0.0142	0.155***	0.147***		0.113***	
	(7.68)	(-0.57)	(8.51)	(6.99)		(3.13)	
_cons	8.024***	6.487***	6.849***	7.513***	6.677***	7.580***	7.225***
	(35.15)	(25.99)	(32.66)	(30.26)	(20.11)	(18.23)	(13.23)

N	27698	3811	11025	19748	6492	7950	2715
R-sq	0.432	0.204	0.365	0.399	0.409	0.316	0.305

Table A.6. The effect of environmental risks on consumption changes over time of 'Panel' households in 2010-12 and 2012-14

	All	Poor	B40	Rural	Rural 2012-14	Urban	Urban 2012-14
				Dependent variable: Change in per-capita expenditure			
Air pollution	**-12.37***	6.040	-0.0273	-4.189	-3.224	-34.10	-41.43
	(-1.91)	(1.52)	(-0.01)	(-0.86)	(-0.42)	(-1.58)	(-1.61)
Tree cover loss	-4.166	-1.376	-5.865	-4.605	**-13.16***	-0.818	-5.808
	(-0.73)	(-0.40)	(-1.63)	(-0.83)	(-1.92)	(-0.03)	(-0.11)
Land degradation	0.262	0.554	0.0442	**1.555***	0.542	-2.124	-2.237
	(0.33)	(0.96)	(0.09)	(2.13)	(0.47)	(-1.15)	(-0.72)
Slope	8.262	-17.99	4.052	-2.692	-1.030	38.90	67.10
	(0.43)	(-0.93)	(0.30)	(-0.16)	(-0.04)	(0.73)	(0.91)
Rainfall variability	-0.162	**-3.139***	0.445	-0.349	-0.132	-0.250	**-15.18***
	(-0.08)	(-1.71)	(0.32)	(-0.17)	(-0.04)	(-0.04)	(-1.72)
Temperature variability	**974.5***	193.5	182.0	377.8	403.0	2582.1	**6247.0****
	(1.74)	(0.61)	(0.67)	(0.88)	(0.63)	(1.42)	(2.40)
Flood hazard	-0.390	0.110	**1.533****	-0.0430	-0.602	-4.244	-3.479
	(-0.38)	(0.10)	(2.33)	(-0.05)	(-0.45)	(-1.30)	(-0.99)
Drought hazard	-2.442	**-121.1****	-64.84	-35.65	53.63	137.7	58.11
	(-0.05)	(-2.06)	(-1.55)	(-0.72)	(0.67)	(0.89)	(0.23)
<u>Control variables</u>							
Current rainfall	1.259	0.656	-0.458	1.625	0.635	-0.560	2.514
	(1.09)	(0.89)	(-0.66)	(1.59)	(0.40)	(-0.16)	(0.50)
Current temperature	-190.0**	-37.60	-48.73	-103.5	-40.98	-406.5*	-239.6
	(-2.20)	(-0.57)	(-0.90)	(-1.32)	(-0.22)	(-1.69)	(-0.46)
Long-term rainfall	1.080	5.660***	1.731	-0.469	0.421	6.838	24.23*
	(0.41)	(2.69)	(1.03)	(-0.20)	(0.10)	(0.85)	(1.89)
Long-term temperature	54.08**	-44.43***	9.712	25.99	59.33*	109.1**	226.8***
	(2.48)	(-2.74)	(0.74)	(1.20)	(1.93)	(2.04)	(2.85)
Distance city	2.372**	0.965	1.647**	1.450	1.915	3.100	0.678
	(2.24)	(1.33)	(2.27)	(1.61)	(1.28)	(1.20)	(0.17)
Distance road	5.620	3.284	5.966**	2.183	17.50***	15.10	13.03
	(1.15)	(1.13)	(1.97)	(0.49)	(2.64)	(0.65)	(0.47)
Area agriculture	13.91***	8.732**	14.39	12.56***	8.157**	19.83	39.26*
	(2.59)	(2.17)	(1.64)	(2.62)	(2.24)	(1.09)	(1.93)
Area forest	0.336	0.146	0.155	0.315	0.209	22.92	35.49
	(0.28)	(0.09)	(0.17)	(0.28)	(0.13)	(0.63)	(0.72)
Area water surface	25.81**	24.64	11.20	33.36***	36.21***	-54.07	-130.1
	(2.01)	(0.89)	(1.47)	(3.80)	(4.73)	(-1.18)	(-1.53)
Workforce	190.6***	166.7***	89.93**	208.4***	228.1***	127.9	-489.4
	(2.63)	(2.82)	(2.17)	(3.42)	(2.72)	(0.44)	(-1.08)
Education	117.4***	40.56	67.02***	73.88***	88.50***	235.3***	203.1***
	(5.75)	(1.40)	(5.05)	(4.26)	(3.77)	(4.02)	(3.35)
Age head	-2.285	-3.548***	-2.276**	-1.553	-4.078*	-4.467	-5.595
	(-1.60)	(-3.09)	(-2.53)	(-1.14)	(-1.94)	(-1.18)	(-0.95)
Female head	85.89	28.10	30.55	49.79	26.04	193.3	385.3*
	(1.52)	(0.64)	(0.91)	(1.03)	(0.33)	(1.44)	(1.94)
Minority	-152.8***	175.7***	234.9***	-149.6**	-204.7**	-179.1	-702.7**
	(-2.63)	(3.27)	(5.47)	(-2.56)	(-2.09)	(-0.80)	(-2.09)
Year 2012-14	139.8	-101.7	-128.8**	96.08		202.4	
	(1.35)	(-1.46)	(-2.24)	(1.04)		(0.71)	
_cons	-1943.4**	188.1	-784.5*	-542.3	-1461.6	-5280.7**	-12451.3***
	(-2.25)	(0.39)	(-1.70)	(-0.73)	(-1.38)	(-2.17)	(-3.05)
N	7957	952	3250	5804	2792	2153	1109
R-sq	0.017	0.171	0.076	0.020	0.035	0.029	0.050

Notes: The table indicates coefficients estimated from 'Panel' model using Ordinary Least Squares and differences over time for time-variant variables. * 0.10 ** 0.05 *** 0.01 significance level. Values in parentheses indicate standard errors corrected for cluster correlation at commune-level. B40 denotes households in the bottom two consumption quintiles.

Sources: Authors' calculation based on socio-economic data from VHLSS 2010, 2012 and 2014 and environmental data from Brauer *et al*., 2015, Hansen *et al*., 2013, Vu *et al*., 2014, Harmonized World Soil Database, Climate Research Unit, Bangalore *et al*., 2016, and Winsemius *et al*., 2015.

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