

Online Appendix

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Appendix A Balance Checks

Table A.1 PSM: Balance Test Results (Industry Included)

Outcome: Penalty	Unmatched/Matched	Mean		Standardized Mean Difference	t-test	
		Punished	Not Punished		t-value	p-value
<i>Panel A: Water-related Sanctions</i>						
Output (log)	U	7.14	7.11	0.01	-0.10	0.92
Output (log)	M	7.14	7.17	0.01	0.07	0.94
Business Start Year	U	2,001.31	2,001.37	0.01	0.08	0.94
Business Start Year	M	2,001.31	2,002.39	0.11	1.09	0.28
Distance to Hunan EED	U	187.84	174.19	0.13	-1.75	0.08
Distance to Hunan EED	M	187.84	195.33	0.07	0.69	0.49
<i>Panel B: Air-related Sanctions</i>						
Output (log)	U	7.44	7.11	0.10	-1.08	0.28
Output (log)	M	7.44	7.32	0.04	-0.30	0.77
Business Start Year	U	2,000.17	2,001.37	0.10	1.05	0.30
Business Start Year	M	2,000.17	2,000.66	0.04	0.32	0.75
Distance to Hunan EED	U	173.55	174.19	0.01	0.07	0.95
Distance to Hunan EED	M	173.55	178.47	0.05	0.38	0.70

Table A.2 CEM: Balance Test Results (Industry Exactly Matched)

Outcome: Penalty	Unmatched/Matched	Mean		Standardized Mean Difference	t-test	
		Punished	Not Punished		t-value	p-value
<i>Panel A: Water-related Sanctions</i>						
Output (log)	U	7.14	7.11	0.01	-0.10	0.92
Output (log)	M	7.21	7.09	0.02	-0.36	0.72
Business Start Year	U	2,001.31	2,001.37	0.01	0.08	0.94
Business Start Year	M	2,001.33	2,001.46	0.00	0.00	1.00
Distance to Hunan EED	U	187.84	174.19	0.13	-1.75	0.08
Distance to Hunan EED	M	190.73	188.77	0.01	-0.22	0.83
<i>Panel B: Air-related Sanctions</i>						
Output (log)	U	7.44	7.11	0.10	-1.08	0.28
Output (log)	M	7.53	7.64	0.01	0.31	0.76
Business Start Year	U	2,000.17	2,001.37	0.10	1.05	0.30
Business Start Year	M	2,000.25	2,000.51	0.00	0.00	1.00
Distance to Hunan EED	U	173.55	174.19	0.01	0.07	0.95
Distance to Hunan EED	M	174.87	175.66	0.00	0.07	0.94

**Table A.3-1 Difference between Sanctioned and Unsanctioned Firms before Matching
(Performance Indicators in the First Year, 2011)**

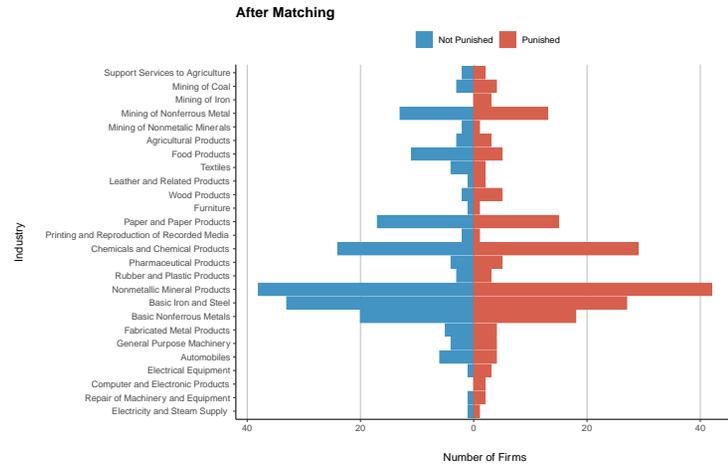
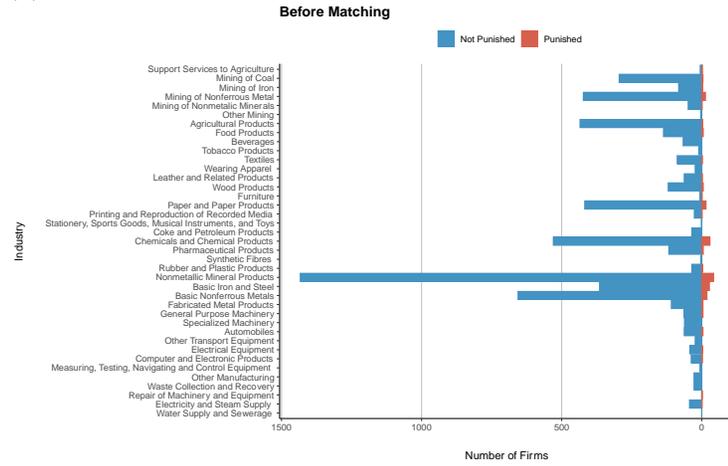
	Unit	Mean		t-test	
		Punished	Not Punished	t-value	p-value
<i>Panel A: Water-related Performance Indicators</i>					
Waste Treatment Spending	10,000 yuan	113.11	114.65	0.02	0.98
Wastewater	ton	337,402.50	245,500.20	-0.59	0.56
COD	ton	42.32	41.19	-0.05	0.96
NH	ton	9.92	14.73	0.79	0.43
Output	10,000 yuan	20,006.20	24,256.52	0.47	0.64
<i>Panel B: Air-related Performance Indicators</i>					
Waste Treatment Spending	10,000 yuan	431.04	146.16	-0.75	0.46
Waste Air	10,000 m ³	44,229.49	55,524.51	0.54	0.59
SO ₂	ton	327.74	195.82	-0.65	0.52
NO _x	ton	64.55	185.46	2.21	0.03
Output	10,000 yuan	23,762.43	24,256.52	0.04	0.97

**Table A.3-2 CEM: Difference between Treatment and Control Firms after Matching
(Performance Indicators in the First Year, 2011)**

	Unit	Mean		t-test	
		Punished	Not Punished	t-value	p-value
<i>Panel A: Water-related Performance Indicators</i>					
Waste Treatment Spending	10,000 yuan	113.99	92.21	-0.31	0.75
Wastewater	ton	342,855.30	213,788.50	-0.82	0.42
COD	ton	42.96	42.08	-0.04	0.97
NH	ton	9.92	20.69	1.30	0.19
Output	10,000 yuan	19,038.67	15,343.70	-0.40	0.69
<i>Panel B: Air-related Performance Indicators</i>					
Waste Treatment Spending	10,000 yuan	431.04	55.12	-0.99	0.33
Waste Air	10,000 m ³	44,229.49	36,444.82	-0.43	0.67
SO ₂	ton	327.74	105.83	-1.09	0.28
NO _x	ton	64.55	70.43	0.15	0.88
Output	10,000 yuan	22,246.19	15,466.00	-0.47	0.64

Figure A.4 PSM: Distribution of Industries

(A) Water-related Sanctions



(B) Air-related Sanctions

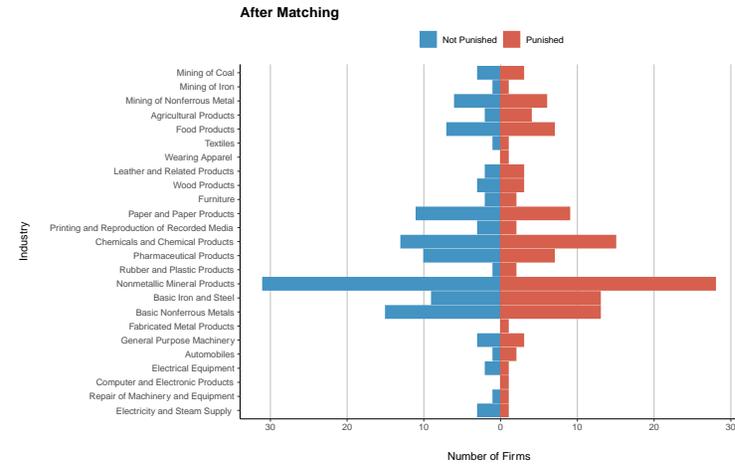
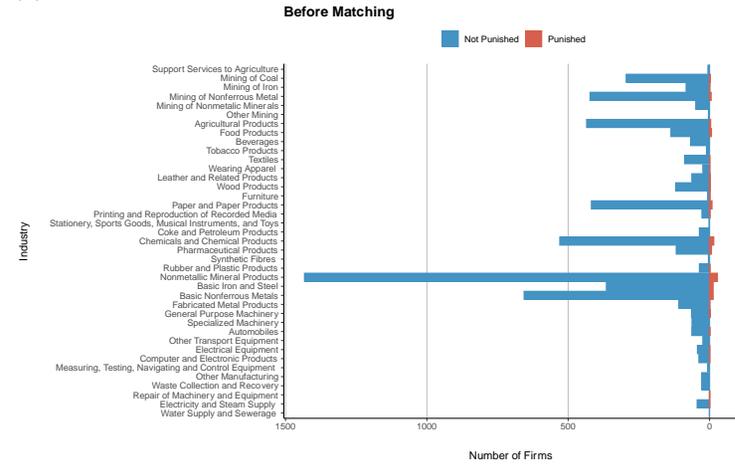


Table A.5 Descriptive Statistics

	Unit	Sanctioned firms				Not sanctioned firms			
		N	Mean	Median	SD	N	Mean	Median	SD
Panel A: Water-related Sanctions									
<i>Environmental Performance</i>									
Waste Water Treatment Spending (log)	10,000 yuan	531	-0.75	1.25	5.90	12,494	0.40	1.61	4.62
Wastewater emission (log)	ton	717	7.07	9.62	8.88	17,083	6.69	9.98	9.24
COD emission (log)	ton	709	-1.22	0.69	6.22	16,694	-0.60	1.08	5.76
NH (log)	ton	458	-5.16	-2.30	7.28	11,108	-4.66	-1.61	7.00
<i>Other Covariates</i>									
Output (log)	10,000 yuan	854	7.29	7.94	4.13	20,846	7.24	7.60	3.40
Business Start Year	year	854	2,000.58	2,004	11.35	20,846	2,000.53	2,004	11.59
Distance to Hunan EED	km	854	189.81	189.37	108.59	20,846	175.33	165.46	101.28
Panel B: Air-related Sanctions									
<i>Environmental Performance</i>									
Waste Air Treatment Spending (log)	10,000 yuan	314	0.35	1.61	5.15	11,084	-0.19	1.61	5.59
Waste Air (log)	10,000 m ³	451	7.11	7.87	5.34	16,552	6.89	7.93	5.60
SO ₂ (log)	ton	412	1.61	2.86	5.13	15,330	1.58	2.91	5.19
NO _x (log)	ton	409	-0.05	1.10	4.91	14,761	-0.17	1.25	5.37
<i>Other Covariates</i>									
Output (log)	10,000 yuan	539	7.55	7.82	3.43	20,846	7.24	7.60	3.40
Business Start Year	year	539	2,000.12	2,003	12.33	20,846	2,000.53	2,004	11.59
Distance to Hunan EED	km	539	175.85	167.63	105.83	20,846	175.33	165.46	101.28

a. N is the number of firm-years. b. Emissions, spending and outputs are annual data.

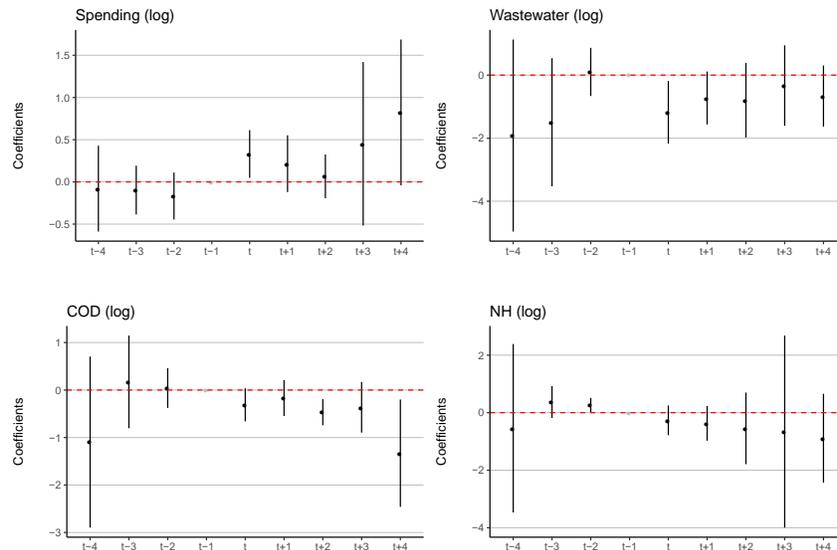
Appendix B Alternative Samples

Table B.1 Effects of Sanctions on Environmental Performance (Unmatched Full Sample)

<i>Panel A: Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.35** (0.17)	-0.73 (0.46)	-0.28* (0.16)	-0.45** (0.20)
N of Treated Firms	13025	17800	17403	11566
R^2	0.96	0.86	0.93	0.95
<i>Panel B: Air-related Sanctions</i>				
Model	(5)	(6)	(7)	(8)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.03 (0.19)	-0.15 (0.17)	0.05 (0.22)	0.35* (0.21)
N of Treated Firms	11398	17003	15742	15170
R^2	0.96	0.96	0.95	0.92
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the unmatched full sample.

Figure B.2 Time Path of the Difference between Treatment and Control Firms using Unmatched Full Sample



- Black solid dots reflect estimated coefficients on indicator variables from Equation 2.
- Solid lines reflect 95 percent confidence intervals.
- Grey solid dot reflects the base year, t-1.
- The results are based on the unmatched full sample.

Table B.3 the Effects of Sanctions on Environmental Performance Indicators (including Firms Being Punished in Multiple Years)

<i>Panel A: Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.39*	-0.55	-0.28*	-0.71***
	(0.21)	(0.45)	(0.17)	(0.23)
N of Treated Firms	125	172	170	129
R^2	0.91	0.90	0.96	0.93
<i>Panel B: Air-related Sanctions</i>				
Model	(5)	(6)	(7)	(8)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.03	-0.15	0.13	0.19
	(0.20)	(0.14)	(0.26)	(0.24)
N of Treated Firms	82	114	103	103
R^2	0.97	0.99	0.90	0.93
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.

Table B.4 the Effects of Sanctions on Environmental Performance Indicators (Wastewater-only and Waste Air-only Sanctions)

<i>Panel A: Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.36	-0.94*	-0.29	-0.81**
	(0.27)	(0.54)	(0.27)	(0.38)
N of Treated Firms	67	90	90	68
R^2	0.94	0.92	0.97	0.97
<i>Panel B: Air-related Sanctions</i>				
Model	(5)	(6)	(7)	(8)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	-0.09	-0.18	-0.75	-0.38
	(0.16)	(0.30)	(0.65)	(0.71)
N of Treated Firms	20	26	22	24
R^2	0.97	0.99	0.87	0.94
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.

Appendix C Alternative CEM Setups

Table C.1 the Effects of Sanctions on Environmental Performance Indicators (CEM based on the First Year, 2011)

<i>Panel A: Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.56**	-0.33	-0.33	-0.77**
	(0.27)	(0.45)	(0.25)	(0.36)
N of Treated Firms	86	111	111	82
R^2	0.86	0.88	0.91	0.90
<i>Panel B: Air-related Sanctions</i>				
Model	(5)	(6)	(7)	(8)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.08	-0.12	0.12	0.09
	(0.24)	(0.14)	(0.38)	(0.32)
N of Treated Firms	51	64	57	59
R^2	0.98	0.99	0.89	0.92
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.

Table C.2 the Effects of Sanctions on Environmental Performance Indicators (Adding City GDP to CEM)

<i>Panel A: Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.46**	-0.62	-0.24	-0.89***
	(0.21)	(0.49)	(0.19)	(0.33)
N of Treated Firms	125	168	167	128
R^2	0.97	0.89	0.95	0.95
<i>Panel B: Air-related Sanctions</i>				
Model	(5)	(6)	(7)	(8)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	-0.04	-0.07	0.23	0.15
	(0.26)	(0.14)	(0.32)	(0.29)
N of Treated Firms	78	109	98	98
R^2	0.97	0.99	0.93	0.96
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.

Appendix D Placebo Tests

Table D.1 the Effects of Sanctions on Environmental Performance Indicators (Placebo Tests)

<i>Panel A: Effects of Air-related Sanctions on Water-related Performance Indicators</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.52	-0.83	0.54	0.10
	(0.72)	(1.31)	(0.61)	(0.62)
N of Treated Firms	21	30	30	24
R^2	0.94	0.96	0.94	0.93
<i>Panel B: Effects of Water-related Sanctions on Air-related Performance Indicators</i>				
Model	(5)	(6)	(7)	(8)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	-0.18	0.01	0.04	-0.13
	(0.30)	(0.10)	(0.18)	(0.28)
N of Treated Firms	57	87	79	70
R^2	0.98	0.98	0.96	0.99
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.

Appendix E Sanctions and Output

Table E.1 the Effects of Sanctions on Output

	<i>Water-related Violations</i>	<i>Air-related Violations</i>
Model	(1)	(2)
DV	Output	Output
	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.01	0.03
	(0.19)	(0.22)
N of Treated Firms	197	128
R^2	0.97	0.97
Firm FEs	Yes	Yes
Year FEs	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.

Appendix F Heterogeneity of Treatment Effects

In this section, we present heterogeneous treatment effects of sanctions. We categorize punished firms into subgroups based on the industry they are in and their size.

- In Table F.1, we create a dummy variable of dirty industries, I_i , according to an official list published in 2017.
- In Table F.2, I_i is a continuous variable indicating industrial emission intensities of 2010. To get this variable, we divide total wastewater and waste air of firms above the designated size in each two-digit level industry by their total output.
- Table F.3 shows the heterogeneous treatment effect of sanctions placed on firms with different sizes. S_i is a dummy variable. It takes 1 if a firm's output is above the median level within the sample.

Table F.1 Dirty Industries - 1

<i>Panel A: Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.34	-0.61	-0.35***	-0.63*
	(0.21)	(0.64)	(0.12)	(0.33)
$D_{i,j} \times I_i$	0.08	0.07	0.11	-0.18
	(0.27)	(0.78)	(0.24)	(0.37)
N of Treated Firms	125	169	168	128
R^2	0.91	0.90	0.96	0.93
<i>Panel B: Air-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.04	-0.11	-0.11	0.10
	(0.23)	(0.17)	(0.20)	(0.18)
$D_{i,j} \times I_i$	-0.00	-0.06	0.38	0.18
	(0.36)	(0.24)	(0.43)	(0.41)
N of Treated Firms	79	111	100	100
R^2	0.97	0.99	0.89	0.93
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.

Table F.2 Dirty Industries - 2

<i>Panel A: Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.33	-0.77	-0.28	-0.69**
	(0.23)	(0.56)	(0.19)	(0.29)
$D_{i,j} \times I_i$	0.01	0.03	0.00	-0.01
	(0.01)	(0.02)	(0.01)	(0.01)
N of Treated Firms	125	169	168	128

R^2	0.91	0.90	0.96	0.93
-------	------	------	------	------

Panel B: Air-related Sanctions

Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.07 (0.30)	-0.23 (0.18)	0.16 (0.35)	0.43 (0.30)
$D_{i,j} \times I_i$	-0.03 (0.17)	0.07 (0.11)	-0.02 (0.19)	-0.19 (0.23)
N of Treated Firms	79	111	100	100
R^2	0.97	0.99	0.89	0.93
Firm FEs				
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.

Table F.3 Firm Size

Panel A: Water-related Sanctions				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.54* (0.30)	-0.44 (0.66)	-0.43 (0.28)	-0.58 (0.38)
$D_{i,j} \times S_i$	-0.22 (0.35)	-0.15 (0.95)	0.26 (0.33)	-0.33 (0.37)
N of Treated Firms	125	169	168	128
R^2	0.91	0.90	0.96	0.93
Panel B: Air-related Sanctions				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.23 (0.52)	-0.30 (0.21)	0.37 (0.41)	0.22 (0.37)
$D_{i,j} \times S_i$	-0.30 (0.51)	0.29 (0.25)	-0.43 (0.52)	0.00 (0.50)
N of Treated Firms	79	111	100	100
R^2	0.97	0.99	0.89	0.93
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.

Appendix G City-Year Fixed Effects

To rule out potential bias generated by within-city policy changes over time, we substitute city-year fixed effects for year fixed effects in the model. Table G.1 reports the results from CEM. Figure G.2 plots the time path the difference in differences between the punished and the unpunished firms. Although the estimated coefficients of $D_{i,j}$ are statistically insignificant in Model (1) and Model (2), a closer look at Figure G.2 suggests that sanctions increase pollution abatement costs and reduce wastewater emissions in the following year of the implementation. However, such effects do not last beyond one year.

Table G.1 The Effects of Sanctions on Environmental Performance Indicators (City-Year Fixed Effects)

<i>Panel A: Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.55	-0.44	-0.23	-0.94***
	(0.35)	(0.47)	(0.18)	(0.33)
N of Treated Firms	125	169	168	128
R^2	0.91	0.90	0.96	0.94
<i>Panel B: Air-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.03	-0.17	0.13	0.25
	(0.23)	(0.15)	(0.28)	(0.27)
N of Treated Firms	79	111	100	100
R^2	0.97	0.99	0.89	0.94
Firm FEs	Yes	Yes	Yes	Yes
City-Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

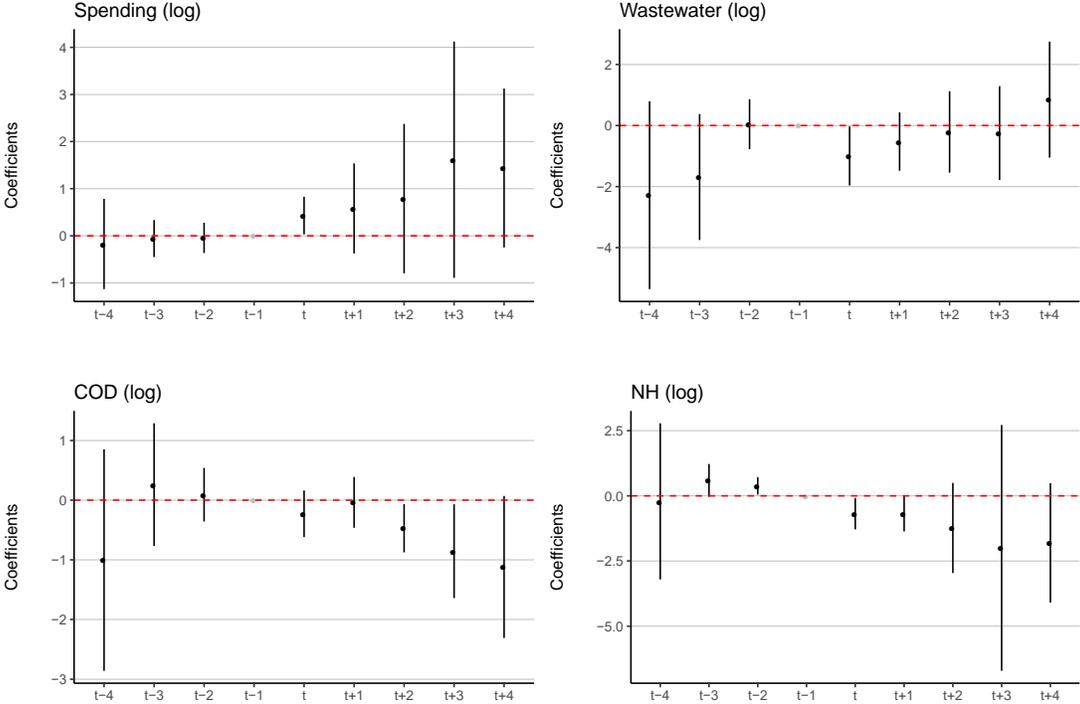
a. * significant at 10%; ** significant at 5%; *** significant at 1%.

b. Standard errors are clustered at the firm level.

c. $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.

d. The results are based on the CEM approach.

Figure G.2 Time Path of the Difference between Treatment and Control Firms with City-Year Fixed Effects



- a. Black solid dots reflect estimated coefficients on indicator variables from Equation 2.
- b. Solid lines reflect 95 percent confidence intervals.
- c. Grey solid dot reflects the base year, t-1.
- d. The results are based on the CEM approach.

Appendix H

Alternative Sanction Type Coding Rules

We use three ways to code sanction types:

1. Table H.1

- We first removed sanctions whose types cannot be determined by the original text documents.
- Then, we recode *Correction*, *Fine*, *Suspension* so that they are mutually exclusive. The coding rule is as follows: first, if a firm receives a suspension, the other two types are turned into 0 if either of them was 1; after the first step has been done, if a firm receives a fine, the correction type is changed into 0 if the type was 1.

2. Table H.2

- We first removed sanctions whose types cannot be determined by the original text documents.
- We also removed observations with more than one type of sanctions to keep only mutually exclusive ones.

3. Table H.3

- We first removed sanctions whose types cannot be determined by the original text documents.
- Then we created separate categories for sanctions with multiple types.

Table H.1 Correction, Fine, and Suspension - 1

<i>Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.65	-0.32	-0.31	-1.06**
	(0.47)	(0.51)	(0.26)	(0.51)
$D_{i,j} \times Fine_i$	-0.20	-0.19	0.10	0.45
	(0.53)	(1.03)	(0.38)	(0.56)
$D_{i,j} \times Suspension_i$	-0.03	-0.03	0.11	0.42
	(0.57)	(0.99)	(0.46)	(0.62)
N of Treated Firms	96	133	132	99
R^2	0.90	0.90	0.96	0.93
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.
- The reference group is Correction.
- Sanctions whose types cannot be determined by the original text documents are removed.

Table H.2 Correction, Fine, and Suspension - 2

<i>Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	SO₂	NO_x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.50	-0.32	-0.28	-0.71
	(0.41)	(0.50)	(0.31)	(0.56)
$D_{i,j} \times Fine_i$	-0.36	0.40	0.22	0.48
	(0.48)	(0.60)	(0.47)	(0.81)
$D_{i,j} \times Suspension_i$	-0.47	-0.94	-0.42	-0.08
	(0.44)	(1.65)	(0.55)	(1.01)
N of Treated Firms	65	90	89	63
R^2	0.99	0.91	0.97	0.98
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.
- The reference group is Correction.
- Sanctions whose types cannot be determined by the original text documents are removed.
- Observations with more than one type of sanctions are removed.

Table H.3 Correction, Fine, and Suspension - 3

<i>Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.65	-0.32	-0.31	-1.06**
	(0.47)	(0.51)	(0.26)	(0.51)
$D_{i,j} \times Fine_i$	-0.38	0.37	0.28	0.58
	(0.50)	(0.61)	(0.44)	(0.76)
$D_{i,j} \times Suspension_i$	-0.49	-0.95	-0.37	0.02
	(0.46)	(1.66)	(0.54)	(0.98)
$D_{i,j} \times Fine_i \cap Correction_i \cap Suspension_i$	2.42	0.03	-0.92	1.21
	(3.40)	(0.48)	(0.67)	(1.19)
$D_{i,j} \times Fine_i \cap Correction_i$	0.04	-0.90	-0.13	0.31
	(0.77)	(2.05)	(0.57)	(0.59)
$D_{i,j} \times Fine_i \cap Suspension_i$	-0.17	0.77	1.11	0.35
	(0.57)	(0.57)	(1.23)	(0.49)
$D_{i,j} \times Correction_i \cap Suspension_i$	-0.08	1.44	0.55	0.76
	(0.63)	(1.33)	(0.63)	(0.84)
N of Treated Firms	96	133	132	99
R^2	0.90	0.90	0.96	0.93
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

- * significant at 10%; ** significant at 5%; *** significant at 1%.
- Standard errors are clustered at the firm level.
- $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.
- The results are based on the CEM approach.
- The reference group is Correction.
- Sanctions whose types cannot be determined by the original text documents are removed.

Appendix I Repeated Sanctions in One Year

Table I.1 Distribution of Repeated Sanctions in One Year

<i>Water-related Sanctions</i>							
Times of Sanctions in One Year	1	2	3	4	5	6	Total
N of Firms	116	64	14	4	1	2	201
<i>Air-related Sanctions</i>							
Times of Sanctions in One Year	1	2	3	4	5	6	Total
N of Firms	79	38	10	1	0	2	130

Table I.2 Repeated Sanctions in One Year

<i>Panel A: Water-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.44	-0.67	-0.48*	-0.98***
	(0.27)	(0.70)	(0.25)	(0.33)
$D_{i,j} \times R_i$	-0.10	0.22	0.40	0.44
	(0.31)	(0.90)	(0.33)	(0.38)
N of Treated Firms	125	169	168	128
R^2	0.91	0.90	0.96	0.93
<i>Panel B: Air-related Sanctions</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	SO ₂	NO _x
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.40	0.26	-0.16	-0.57*
	(0.36)	(0.73)	(0.37)	(0.34)
$D_{i,j} \times R_i$	0.10	-1.51	-0.04	0.12
	(0.44)	(1.48)	(0.38)	(0.40)
N of Treated Firms	79	111	100	100
R^2	0.94	0.91	0.95	0.90
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

e. * significant at 10%; ** significant at 5%; *** significant at 1%.

f. Standard errors are clustered at the firm level.

g. $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.

h. The results are based on the CEM approach.

Appendix J Why firms only respond to water-related sanctions?

In our main analysis as well as in a battery of robustness checks, we find consistently that firms only respond to water-related sanctions. After receiving an air-related sanction, we do not observe an increase in air related environmental spending and decrease in air pollutant emissions. Why are there such different firm responses between water and air-related sanctions?

Visibility and Traceability: Some might also consider this result counter-intuitive, because compared to water pollution, air pollution is more visible and tends to afflict urban areas (Cao and Prakash 2012). If this is the case, it is more likely that air-related sanctions would affect firms' behaviors more than water-related sanctions. However, the difference in visibility discussed above often is from the perspective of the public, not from the perspective of local regulators. Given the political context of China (e.g., lack of pressure from local elections and NGO activities), the public's view on the relative severity of local air vs. water pollution might not translate into local regulators' issue attention. Regulators rely much less on the overall visibility of a pollutant because they have access to professional monitoring equipment and data. Traceability – how well one can trace the source of pollution back to a particular firm – matters more for local regulators when it comes to issuing sanctions. As far as we know, there is no consensus on whether water pollution is more traceable than air pollution or vice versa, because there are many mediating factors. For example, the traceability of water pollution often depends on how stationary the water is.

Therefore, in the Chinese context, the overall visibility between air and water pollution does not explain why firms only respond to water-related sanctions – if visibility is a factor, it actually predicts the opposite from what we find empirically: firms should have responded more to air-related sanctions. We have also discussed the issue of traceability of air vs. water pollutants. To test whether this might explain our finding, we conduct an indirect test by differentiating between nationally key monitored firms from rest of the firms in our sample. The assumption here, which we think is reasonable, is that all else equal, pollutants from nationally key monitored firms should be more traceable because the central government have required the installation of more monitoring devices in these firms. Therefore, if traceability matters for how a firm responds to a sanction, we should expect more response from a national key monitored firm because its pollutants are more traceable. To test this, we estimate the following model:

$$\ln(y_{i,t}) = \beta_0 + \beta_1 D_{i,t} + \beta_2 D_{i,t} \times State\ key_{i,t} + \beta_3 X_{i,t} + \delta_i + \gamma_t + \epsilon_{i,t}$$

State key_{i,t} is a binary indicator for nationally key monitored firms. The results are in Table J.1: there is no effect associated with nationally key monitored firms, suggesting that traceability is probably not a reason why firms only respond to water-related sanctions.

Table J.1 Testing the Mediating Effect of Nationally Key Monitored Firms

<i>Panel A: Water-Related Violations</i>				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.32*	-0.62	-0.24	-0.78***
	(0.19)	(0.49)	(0.19)	(0.27)
$D_{i,j} \times State\ Key_{i,j}$	1.06	1.00	-0.70	0.31

	(1.09)	(1.19)	(0.48)	(0.53)
N of Treated Firms	125	169	168	128
R^2	0.91	0.90	0.96	0.93
Panel B: Air-Related Violations				
Model	(1)	(2)	(3)	(4)
DV	Spending	Wastewater	COD	NH
	<i>logged</i>	<i>logged</i>	<i>logged</i>	<i>logged</i>
$D_{i,j}$	0.04	-0.14	0.14	0.22
	(0.23)	(0.15)	(0.29)	(0.27)
$D_{i,j} \times State Key_{i,j}$	-0.12	-0.09	-0.19	-0.18
	(0.24)	(0.17)	(0.29)	(0.32)
N of Treated Firms	79	111	100	100
R^2	0.97	0.99	0.89	0.93
Firm FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Output (log)	Yes	Yes	Yes	Yes

a. * significant at 10%; ** significant at 5%; *** significant at 1%.

b. Standard errors are clustered at the firm level.

c. $D_{i,j}$ takes the value of 1 in and after the year in which a firm was punished.

d. The results are based on the CEM approach.

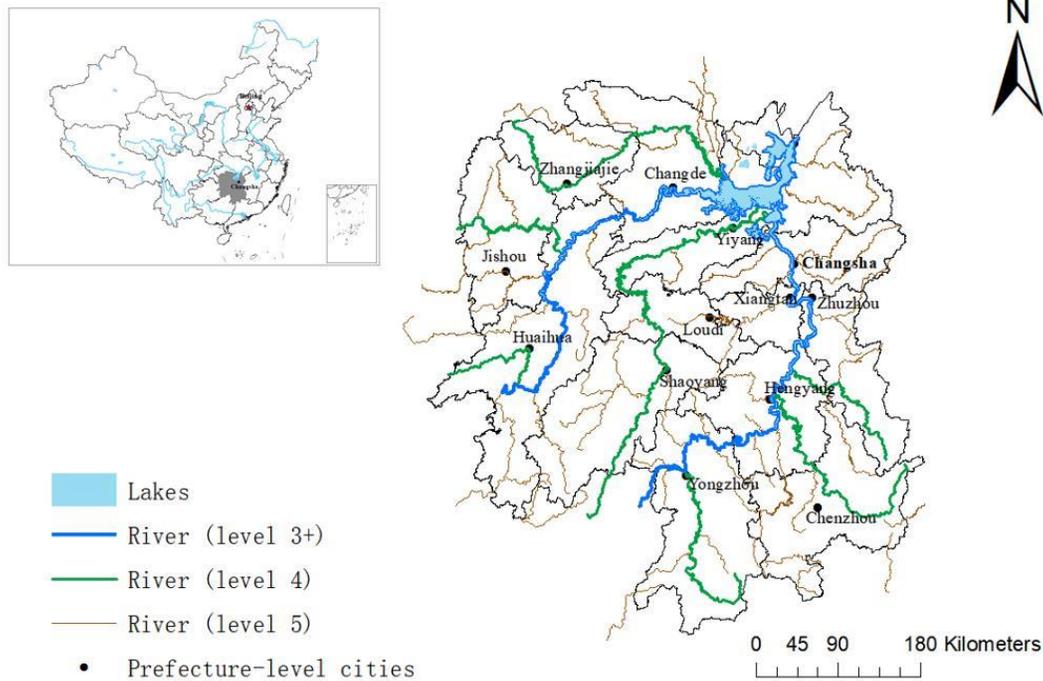
Provincial Policy Priorities: After ruling out pollutant visibility and traceability as two potential explanations, our favorite explanation is that the discrepancy between the two pollution sources may have to do with the salience of the water pollution issue on Hunan's public and political agenda. Compared to air pollution, water pollution is a much more important issue for Hunan and the provincial government prioritizes water pollution reduction. Governments at different levels within the province attach a great importance to water pollution control. For instance, in 2013, the province defined the protection and remediation of the Xiang River as its No. 1 key project (一号重点工程). In the following we provide a more detailed discussion on 1) why water pollution is such an important issue for Hunan compared to air pollution, 2) the central government's policy emphasis on water pollution for Hunan as well as evidence from Hunan provincial government's annual reports that water pollution reduction is much more prioritized than air pollution reduction; and 3) the public in Hunan pay more attention to water pollution as reflected in Baidu search volume index (SVI).

1). Water, water pollution, and their importance to the provincial economy: Hunan locates along the central to southern reaches of the Yangtze River. It has one of the largest lakes, the Dongting Lake, in the country. Figure J.2 shows the major rivers and lakes in Hunan. It is hard to exaggerate the importance of rivers and lakes for the Hunan province. Based on the 2018 data from the Hunan Statistical Yearbook, there are 5,341 rivers over 5 kilometers in the province. The main rivers are Xiangjiang, Zishui, Yuanjiang and Lishui. The total of all watershed areas in the province is 178,692 square kilometers: this is 84.37% of the total provincial surface area.

At the same time, since Hunan is home to an abundance of mineral resources, intensive mining activities have contaminated local soils and watersheds. The consequences are severe: an analysis of soil and brown rice samples from Hunan suggests that mining activities lead the mean concentrations of cadmium and mercury to exceed the national standard for food safety (Zeng et al. 2015). A local NGO focusing on water quality, Green Hunan, has organized campaigns and protests to foster public awareness and demand government intervention in projects with high potential for water pollution (Du 2016).

Compared with the severity of water pollution, Hunan is far from being among the hotspots of air pollution in the country: Figure J.3 presents the SO₂ data from NASA satellite for year 2005. This is probably the reason why in the 11th Five-year Plan (2006-2010), the SO₂ reduction target imposed by the central government for Hunan is relatively low. Table J.4 shows a 9% reduction target for Hunan, which is much lower than those for Beijing, Shanghai, and Hebei.

Figure J.2 Major Lakes and Rivers in Hunan



Note: On the map of China in the upper left corner, the blue line represents 1-2 level/grade rivers, which are China's main water system. (Chinese rivers can be divided into 1-5 grades: grade 1 river is the most important river, grade 5 is the smallest, and tributary.) On the map of Hunan Province: the thick blue line represents rivers above grade 3, namely 1-3 Level river. The green line level 4 rivers, and the brown line level 5 rivers.

Figure J.3 County-level Annual Averages of SO₂ Concentration, 2005

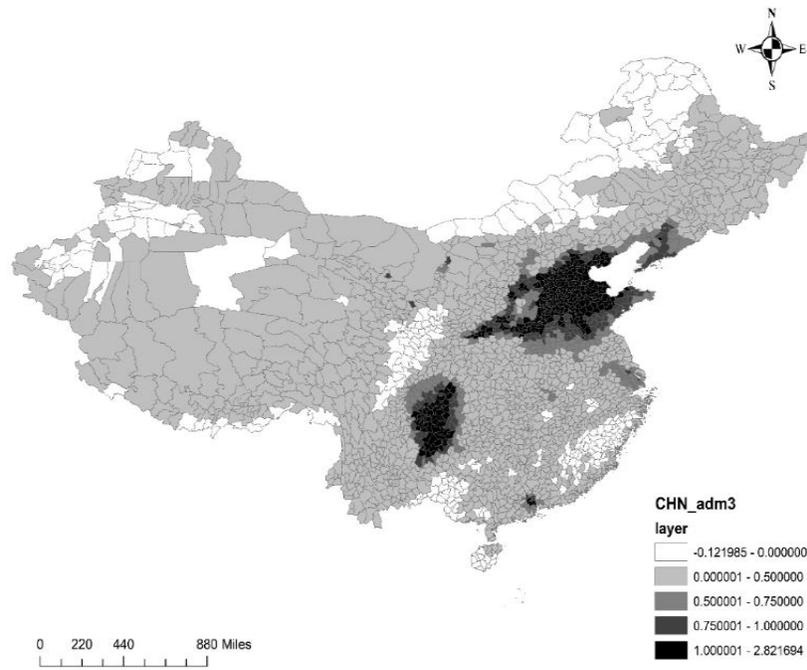


Table J.4 Pollution Reduction Targets from the 11th Five-Year Plan

Province	SO ₂ emissions in 2005	SO ₂ emission targets in 2010		Reduction Percentage (%)
		Total	In which: Electricity sector	
Beijing	19.1	15.2	5	20.4
Tianjin	26.5	24	13.1	9.4
Hebei	149.6	127.1	48.1	15
Shanxi	151.6	130.4	59.3	14
Neimenggu	145.6	140	68.7	3.8
Liaoning	119.7	105.3	37.2	12
Jilin	38.2	36.4	18.2	4.7
Heilongjiang	50.8	49.8	33.3	2
Shanghai	51.3	38	13.4	25.9
Jiangsu	137.3	112.6	55	18
Zhejiang	86	73.1	41.9	15
Anhui	57.1	54.8	35.7	4
Fujian	46.1	42.4	17.3	8
Jiangxi	61.3	57	19.9	7
Shandong	200.3	160.2	75.7	20
Henan	162.5	139.7	73.8	14
Hubei	71.7	66.1	31	7.8
Hunan	91.9	83.6	19.6	9
Guangdong	129.4	110	55.4	15

Guangxi	102.3	92.2	21	9.9
Hainan	2.2	2.2	1.6	0
Chongqing	83.7	73.7	17.6	11.9
Sichuan	129.9	114.4	39.5	11.9
Guizhou	135.8	115.4	35.8	15
Yunan	52.2	50.1	25.3	4
Tibet	0.2	0.2	0.1	0
Shaanxi	92.2	81.1	31.2	12
Guansu	56.3	56.3	19	0
Qinghai	12.4	12.4	6.2	0
Ningxia	34.3	31.1	16.2	9.3
Xinjiang	51.9	51.9	16.6	0

Source: "Reply to *Pollution Control Plan During the Eleventh Five-Year Plan*," issued by the China State Council in 2006.

2). Central government mandates and the provincial government priority: in contract to a relative low target to reduce air pollution, for Hunan, water pollution reduction has always been a priority from the perspective of both the central government and the provincial government. Table J.5 shows that out of the 10 targets established by the provincial government for the 12th Five-year Plan, 6 are specifically about addressing water pollution, 3 are for air pollution, and 1 for industrial solid waste.

Table J.5 Main Indicators of Environmental Protection in Hunan Province during the Twelfth Five-Year Plan

No.	Indicator	Indicator Value		Changes compared to 2010	Indicator attributes
		2010	2015		
1	Total COD emissions (10,000 tons)	134.1	124.4	-7.2%	Binding targets; the number completed in five years, the first four indicators are the national unified targets in the emission reduction responsibility letter signed by the Provincial People's Government and the Ministry of Environmental Protection.
2	Total sulfur dioxide emissions (10,000 tons)	71.0	65.1	-8.3%	
3	Total ammonia nitrogen emissions (10,000 tons)	16.95	15.29	-9.8%	
4	Total nitrogen oxide emissions (10,000 tons)	60.4	55.0	-9.0%	
5	Total lead emissions (tons)	54.04	45.93	-15%	
6	City sewage treatment rate	70%	85%	+15%	The targets that should be achieved by the end of 2015.
7	Comprehensive utilization rate of industrial solid waste	81%	85%	+4%	
8	Provincial control section by function zone water quality compliance rate	88.5%	95%	+6.5%	
9	The water quality compliance rate of the main streams of	85%	95%	+10%	

	Xiang, Zi, Yuan, Li and the first-level tributaries of Cities				
10	The number of city-level cities where the number of days with good air quality above grade 2 exceeds 328	12	13	+1	

Source: Notice of the General Office of the People's Government of Hunan Province on Printing and Distributing the "Twelfth Five-Year Plan for Environmental Protection in Hunan Province."

One item to highlight, which relates to our previous discussion on heavy metal pollution in the water is the target No.5., that is, total lead emissions (tons). Here, the “Implementation Plan for the Treatment of Heavy Metal Pollution in the Xiangjiang River Basin” approved by the State Council in 2011 stated that the treatment must be effective during the 12th Five-Year Plan period. According to the goal of this “Implementation Plan,” by the end of the Twelfth Five-Year Plan (i.e., 2015), the problems of heavy metal pollution in the Xiangjiang River Basin that endanger the health of the people should have been basically solved; the number of firms with heavy metal pollution should have been reduced by 50% compared to 2008; industrial pollution sources should have comprehensively treated and controlled, and heavy metal emissions reduced by 50% compared to 2008.

Another source of evidence that reflects a much more prioritized water pollution issue is the annual provincial government work report. We have downloaded the environmental protection section of the provincial government work reports, 2011-2015. Note that in provincial government work reports, often an overview of the past year’s achievement in a given issue area is first discussed, followed by the targets and goals for the next year. Overall, annual provincial government work reports are the most important documents for a provincial government to communicate policy priorities to the public. Because of space limit, we only present a few highlights in the main text while leaving the whole of the translated provincial government work reports’ environmental sections at the end of this document (there, we use red font for water-related content, blue font for air-related content).

One thing that really stands out is that in the 2011 and 2012 reports, there is no mentioning of air pollution at all. There is only one sentence on air pollution reduction in the 2013 report. At the same time, large sections of the annual provincial government work reports are about water pollution issues:

- In 2011, it was emphasized that the province should “Take the comprehensive management and protection of the Xiangjiang River Basin as a breakthrough point, explore and establish a “resource-saving and environment-friendly ” construction institutional framework, industrial system, and a new type of industrialization and new type of urbanization promotion mechanism.” Moreover, the province should “Seize the opportunity of our province as a pilot province for water conservancy reform, accelerate water conservancy reform and development, implement the most stringent water resources management system, and strengthen water resources protection and comprehensive water environment management in the Dongting Lake and the “four waters” basin.”
- In 2012: “Implement the most stringent water resources management system, and resolutely maintain the “three red lines” of total water consumption, water efficiency, and water function zones to limit pollution. Accelerate the construction of the “Asia-Europe

Water Resources Research and Utilization Center.” ... We will promptly promulgate the Xiangjiang River Basin management plan and river sand mining management measures, and earnestly promote the special rectification of river sand mining and water catering.”

- In 2013: “Sewage and garbage treatment facilities have achieved full coverage of towns above the county level; the three-year action plan for water pollution control in the Xiangjiang River Basin has been successfully implemented, and the water quality of Xiangjiang River and Dongting Lake has improved significantly. ... Implement the most stringent water resources management system and promote the pilot project of building a national water-saving society.”
- In 2014, the Xiangjiang River Protection and Governance was listed as the Provincial Government’s “No. 1 Key Project.” “With clearer water as the focus, we will promptly implement the first “Three-Year Action Plan” of the Provincial Government’s “No. 1 Key Project.” The Zhutan area is to fully implement the integration of water affairs; highlights the protection of important water source conservation areas, drinking water source areas and key soil erosion prevention and protection areas.”
- In 2015, the Provincial Government Work Report summarizes that the provincial government’s “No. 1 Key Project” for the protection and management of the Xiangjiang River has completed the annual goal: “The Zhubu Port area of Xiangtan took the lead in realizing the closure of all heavy chemical enterprises. The province eliminated 1147 heavy-duty enterprises, withdrew from large-scale breeding, and demolished 1351. With 679,000 square meters, the water quality of the Xiangjiang River continued to improve.”

3). Public attention as reflected in Baidu search volume index (SVI): We measure people attention to a pollution issue by using Baidu’s Search Volume Index (SVI, similar to Google SVI). As the largest search engine in China, Baidu started to reveal the SVI of words for which people commonly search online in 2011. It provides daily SVI for a specific word at both country, province, and city levels.¹

We use the provincial-level monthly averages of SVI to measure the public attention to air vs. water pollution. More generally, we first use the word of “水” (water) vs. “气” (air) and limit our search to the Hunan province between 2011 and 2015. Figure J.6 shows the differences in the SVIs. Clearly, “水” (water) was much more searched than “气” (air).

“水” (water) vs. “气” (air) might be too broad: e.g., “水” (water) might also involve search on drinking water quality. Therefore, we further narrow our search to “水污染” (water pollution) vs. “气污染” (air pollution): Figure J.7 shows the differences: during most of the time between 2011 and 2015, more searches were found for “水污染” (water pollution) than for “气污染” (air pollution).

¹ The Baidu index of any keyword is the value of the keyword in the comparison period/the value of the keyword in the base period. The value of the comparison period and the value of the base period are obtained by comparing the number of user searches on that day with the number of relevant news in the past 30 days in Baidu News.

To better illustrate the differences, we take the differences between “水污染” (water pollution) SVI and “气污染” (air pollution) SVI so that a positive value indicating more “水污染” (water pollution) than “气污染” (air pollution) searches during the same time period. Figure J.8 shows the result, suggesting for most of the time, people in Hunan conducted more searches on “水污染” (water pollution) than “气污染” (air pollution). This is really a strong and interesting result because, as we discussed earlier, in terms of issue visibility, air pollution is often more visible, especially in urban areas where most the Chinese Netizens live. Therefore, finding higher “水污染” (water pollution) SVIs almost consistently than “气污染” (air pollution) SVIs provides strong evidence that water pollution really is a much important issue than air pollution in Hunan.

Figure J.6 Baidu SVI using “水” (water) vs. “气” (air)

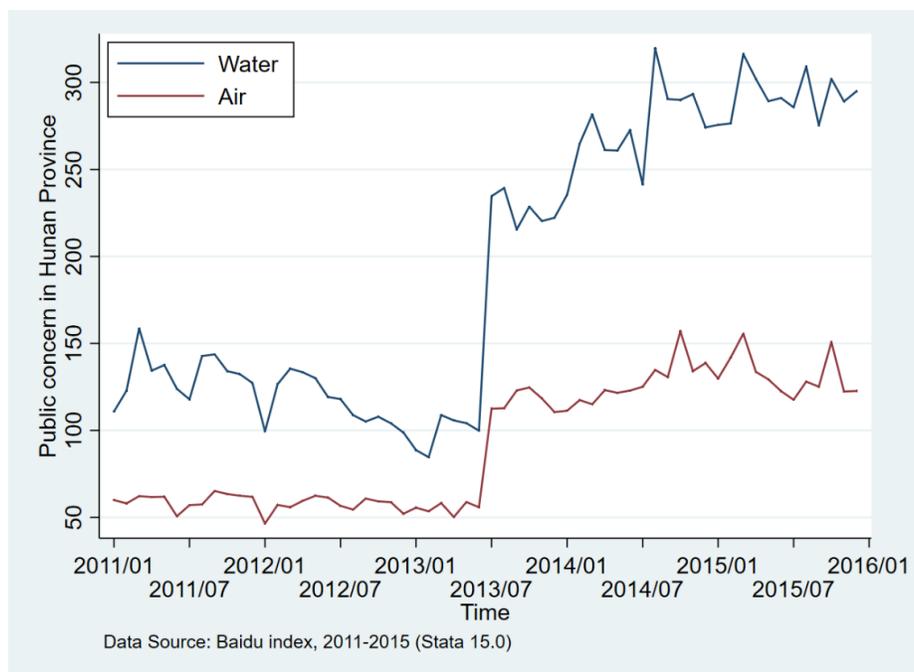


Figure J.7 Baidu SVI using “水污染” (water pollution) vs. “气污染” (air pollution)

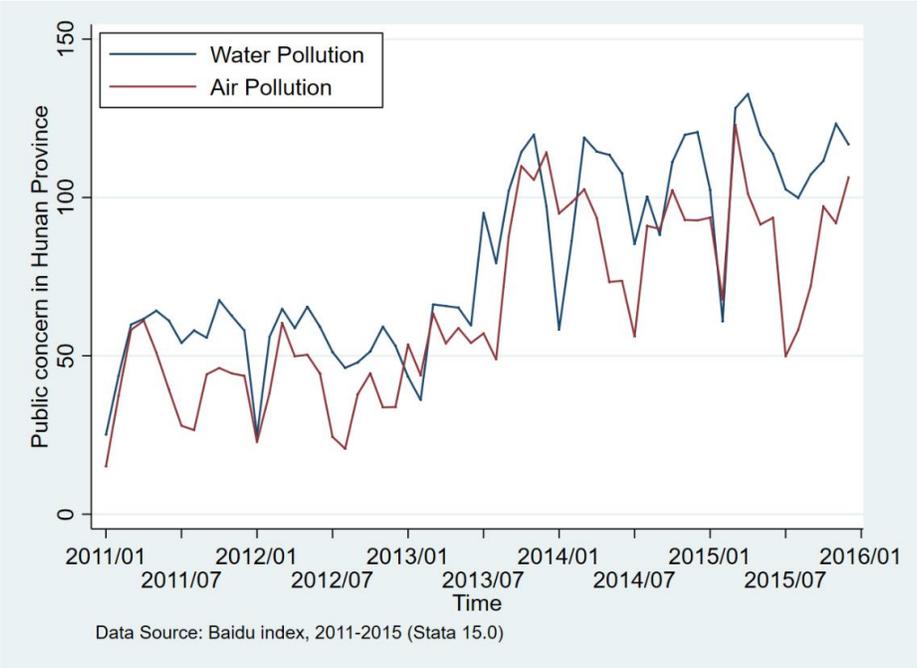
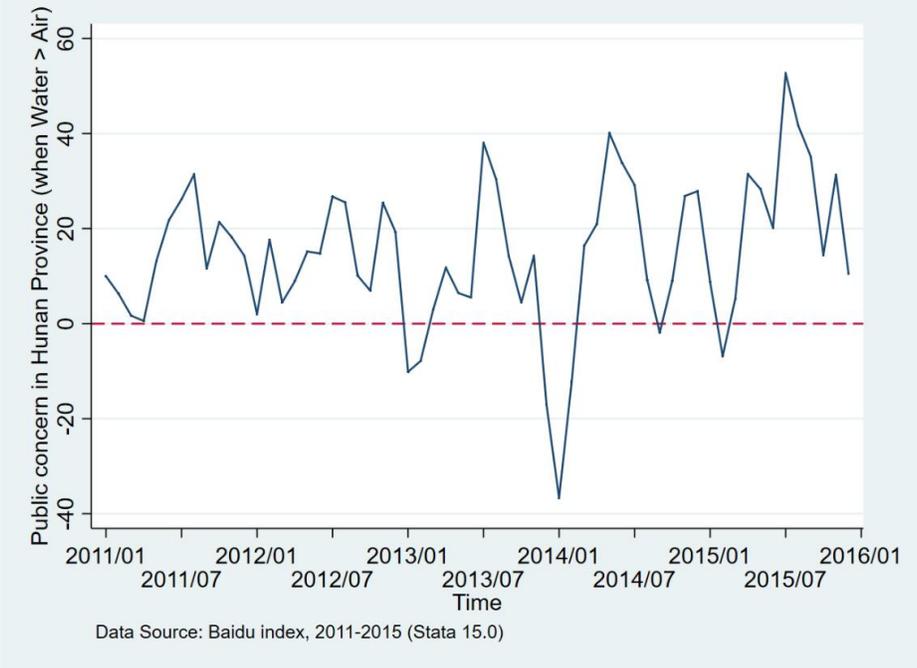


Figure J.8 Differences in Baidu SVI using “水污染” (water pollution) vs. “气污染” (air pollution)



Hunan Provincial Annual Work Reports Translated: we use red font for water-related content, blue font for air-related content.

1. Work report of Hunan Provincial Government in 2011:

1.1 Summary of 2010:

The intensity of environmental protection continued to increase. The targets of energy conservation and emission reduction in the “11th five-year plan” have been fully completed, and 785 key energy-saving projects have been implemented. **The treatment rates of urban sewage and domestic waste above the county level have reached 72% and 50.66% respectively.** The geological disaster prevention and mitigation system has been continuously improved, and the restoration and governance of the mine geological environment has been strengthened. Positive progress has been made in ecological construction, with a forest coverage rate of 57.01% and a forest stock volume of 402 million cubic meters. Langshan successfully applied for world heritage. The development of a sustainable economy has been accelerated, and a number of national and provincial sustainable economy pilot projects have achieved initial results. A number of major pollution prevention and control projects have been implemented, including comprehensive treatment of Dongting Lake and heavy metal pollution control of Xiangjiang River Basin.

1.2 Targets for 2011:

Accelerate the construction of the second phase of the “Changsha-Zhuzhou-Xiangtan” experimental zone. **Taking the comprehensive management and protection of the Xiangjiang River Basin as a breakthrough point, explore the establishment of a resource-saving and environment-friendly society construction institutional framework, industrial system, and a new type of industrialization and new type of urbanization promotion mechanism. Focus on project construction and promote the combination of project management and institutional construction. Focus on the implementation of "eight major projects" such as resource-saving and environment-friendly industrial revitalization, infrastructure construction, full coverage of energy saving and emission reduction, comprehensive management of the Xiangjiang River Basin, promotion of demonstration zone construction, urban and rural coordinated demonstration, integrated transportation integration, and "three networks integration".²** Establish a resource-saving and environment-friendly society industry fund, and accelerate the advancement of pilot reforms such as smart grids. Continue to increase investment in infrastructure construction in the demonstration zone, and promote the scale and level of the "two oriented" leading industry in the demonstration zone. Promulgated the reform implementation plan and overall plan for the eighteen districts of the demonstration zone. Completed the preparation of the protection plan for the watershed of the Shuifumiao Reservoir, and promulgated and implemented the overall plan for the Zhaoshan Ecological Green Heart Area and a number of special plans.

Continue to promote energy conservation and emission reduction. Resolutely eliminate outdated production capacity, and do a good job of energy-saving emission reduction demonstration projects. Implement an energy-saving evaluation and review system for fixed asset investment projects. In-depth implementation of the "Energy Conservation Action for

² The “three networks” means broadband communication network, next-generation radio and television network, next-generation Internet.

Ten Thousand Enterprises", vigorously develop green buildings, promote building energy conservation and transportation energy conservation in accordance with the law, and guide commercial and civil energy conservation. Develop sustainable economy, explore different types of sustainable economy development models such as regions, enterprises, and parks, focus on the construction of urban mineral demonstration bases such as Miluo, Yongxing, and Yiyang Cangshuipu, and speed up national circular economy pilot projects such as Zhuzhou Qingshuitang. Vigorously develop the green economy, strengthen the research and development of green technologies such as low-carbon, clean production, high-efficiency and energy-saving, and pollution control, plan and build a green economy development demonstration zone, and actively advocate green consumption models. Improve the development policy system and guarantee mechanism focusing on the paid use of resources, ecological environment compensation, and green GDP assessment and evaluation, establish a price and compensation mechanism that promotes energy conservation and emission reduction, and promote major pollutant emission rights trading and ecological compensation pilot projects.

Increase environmental protection and ecological construction. Accelerate the construction of ecological security barriers with Dongting Lake, Wuling-Xuefeng Mountains, Nanling Mountains, Mufu-Luoxiao Mountains, and the "Four Rivers" as the main body, traffic arteries and river green channels as the vein, and urban green construction as the focus. **Seize the opportunity of our province as a pilot province for water conservancy reform, accelerate water conservancy reform and development, implement the most stringent water resources management system, strengthen water resources protection and comprehensive water environment management in the Dongting Lake and "Four Rivers" basins.** Focusing on industrial and mining areas such as Qingshuitang, Zhubu Port, and Shuikoushan, comprehensively treat heavy metal pollution in the Xiangjiang River; intensify comprehensive environmental management in the "manganese triangle" area of Huayuan. Strictly meet the discharge of industrial pollutants, start the implementation of the exit plan for heavily polluting industries; strengthen the construction and operation management of urban sewage, domestic garbage and solid waste treatment facilities. Strengthen ecological protection in the source areas of rivers, strengthen the protection and construction of key ecological function areas, and maintain biodiversity. Improve the ability to prevent and mitigate disasters and respond to climate change, and build a system for the prevention and control of foreign pests. Make overall plans to implement major ecological restoration and construction projects, implement geological disaster prevention and geological environmental protection projects, deal with hidden dangers of large and extra-large geological disasters in phases and batches, and strengthen the restoration of the geological environment in key mining areas and the remediation of tailings ponds. Speed up the control of soil erosion, consolidate the results of returning farmland to forests, continue to increase efforts to close hills for afforestation and afforestation, and build a number of "livable cities", "livable towns" and "livable villages".

2. Work report of Hunan Provincial Government in 2012

2.1 Summary of 2011:

Progress in building a two oriented society has been accelerated. The leadership system and work promotion mechanism of the "Changsha-Zhuzhou-Xiangtan" Experimental Zone were

further strengthened, and the second phase of reform and construction was accelerated. Efforts have been made to implement more than 50 reform pilot projects in the national layout, and six “resource-saving and environment-friendly” standard systems, such as “resource-saving and environment-friendly” communities and “resource-saving and environment-friendly” parks, have been issued; the Changsha-Zhuzhou-Xiangtan Urban Agglomeration has been approved as a national pilot zone for integration of informatization and industrialization. Zhuzhou Smelter Co., Ltd., Tailin Paper Co., Ltd. and Xiangtan Iron and Steel Co., Ltd. have become the first batch of pilot projects for establishing “resource-saving and environment-friendly” enterprises. Energy-saving and emission-reduction efforts have been further increased. 113 enterprises have been included in the national plan to close small businesses, and the value-added energy consumption of large-scale industrial units in the province has been reduced by 9%; heavy metal pollution control in the Xiangjiang River Basin has been launched, and the continuous improvement of rural environment has been included in the national pilot; the target assessment of pollution reduction, environmental law enforcement and emergency management were further strengthened. The protection and construction of key ecological function zones are progressing smoothly, with 62800 ha of farmland being converted to forests, and the forest coverage rate has stabilized at 57.01%. The conservation of biodiversity has made solid progress. The prevention and control of geological disasters achieved positive results.

2.2 Targets for 2012:

Promote the second phase of reform and construction of the “Changsha-Zhuzhou-Xiangtan” Experimental Zone. Accelerate the innovation of systems and mechanisms, and take the lead in accumulating experience in resource conservation, environmental friendliness, social management, urban construction, market operation, and factor aggregation. Accelerate the construction of a “resource-saving and environment-friendly” industrial system, implement eight major projects led by the revitalization of “resource-saving and environment-friendly” industries, and actively promote the construction of demonstration areas, full coverage of energy conservation and emission reduction, comprehensive management of the Xiangjiang River Basin, as well as infrastructure construction, urban-rural coordinated demonstration, and integrated transportation integration, “Three networks integration” to promote high-tech, intensified, clean and circular industries. Promote “resource-saving and environment-friendly” standard system and certification system, and carry out “resource-saving and environment-friendly” demonstration project and “resource-saving and environment-friendly” demonstration unit creation activities. Continue to promote emissions trading, carry out pilot projects of green insurance and ecological compensation. Implement energy-saving, water-saving, and environmentally-friendly product consumption policies, advocate green consumption concepts, and guide the masses to consciously integrate into the “resource-saving and environment-friendly”, start from their own and daily life, and form a good atmosphere for mobilization of the whole people and participation of the whole society in the construction of a “resource-saving and environment-friendly” society.

Ensure the completion of energy saving and emission reduction tasks. Implement dual control of energy consumption intensity and total volume, resolutely eliminate outdated production capacity, and strictly control the growth of industries with high energy consumption, high pollution and high emissions. Pay close attention to energy conservation and emission reduction in key fields, industries, and enterprises, carry out the "Energy

Conservation and Low Carbon Action for Ten Thousand Enterprises", promote contract energy management, reduce the energy consumption of key energy-consuming enterprises, and strengthen the construction of supporting facilities for urban sewage and garbage treatment. Promote the development of circular economy and comprehensive utilization of resources, and support the construction of Miluo National Urban Mineral Demonstration Base, Changsha (Liuyang, Ningxiang) National Remanufacturing Demonstration Base, and Hengyang National Kitchen Waste Resource Utilization and Harmless Treatment Pilot City. Improve policies and regulations, scientific and technological support and statistical monitoring systems for energy conservation and emission reduction. Deepen the price reform of resource products, and implement the tiered price reform for residential electricity, water, and gas. For regions that have not completed energy conservation and emission reduction tasks, regional approvals will be implemented. For regions that have not completed the tasks of energy conservation and emission reduction, the approval of projects within the region will be suspended.

Strengthen environmental protection and ecological construction. Start the construction of green Hunan, focus on "one lake and four rivers", strengthen the environmental protection of forests, water systems, wetlands and water conservation areas, river headwaters, and ecologically fragile areas, and actively develop ecological counties (cities), ecological demonstration areas, and ecological Creation of civilized villages and ecological residential communities. **Implement the most stringent water resources management system, and resolutely maintain the "three red lines" of total water consumption, water efficiency, and water function zones to limit pollution. Accelerate the construction of the "Asia-Europe Water Resources Research and Utilization Center"**. Focusing on Shuikou Mountain in Hengyang, Qingshuitang in Zhuzhou, Zhubu Port in Xiangtan, Chenzhou Nonferrous Mining, Processing and Smelting Concentrated Area, Loudi Tin Mine, etc., solidly promote the treatment of heavy metal pollution and the comprehensive treatment of water pollution in the Xiangjiang River Basin. **Promptly promulgate the Xiangjiang River Basin management plan and river sand mining management measures, and earnestly promote the special rectification of river sand mining and water catering.** Increase the harmless treatment rate of urban domestic garbage at or above the county level, and actively promote the harmless centralized treatment of urban sludge. Strengthen the prevention and control of geological disasters and geological environmental protection, and improve the compensation mechanism for the recovery of the mine environment. Consolidate the results of returning farmland to forests, strengthen management and protection of forest resources, and stabilize forest coverage. Establish and improve a strict environmental monitoring system to further strengthen environmental protection law enforcement.

3. Work report of Hunan Provincial Government in 2013

3.1 Summary of 2012:

The construction of a "resource-saving and environment-friendly society" has become a new engine for driving regional development. Implemented 106 original reforms in key areas, and took the lead in promulgating standards, evaluations, supervision, regulations, and demonstration and creation systems for the construction of a "resource-saving and environment-friendly" society. Marked by the successful integration of communications, the

completion of comprehensive three-dimensional transportation in half an hour, the water storage and navigation of the Xiangjiang Changsha comprehensive hub, and the construction of the Xiangjiang scenery belt, the same traffic network, energy integration, information sharing, ecological construction and environmental governance have achieved significant results progress. The leading role of Changsha, Zhuzhou and Xiangtan has increased. The economic aggregates of the three cities accounted for 42.6% of the province's total. The total output value of the ecological economic zones of southern Hunan, western Hunan and Dongting Lake increased by 13.3%, 12.6%, and 13.9% respectively. Start the construction of green Hunan. The task of energy conservation and emission reduction was over fulfilled, and energy consumption per unit of GDP fell by 20.4% in five years; **sewage and garbage treatment facilities have achieved full coverage of towns above the county level; the three-year action plan for water pollution control in the Xiangjiang River Basin has been successfully implemented, the water quality of Xiangjiang River and Dongting Lake has improved significantly**, and Changsha Yanghu Wetland Park has been basically completed. Ecological restoration projects such as comprehensive control of rocky desertification, construction of shelter forests, protection of important water sources, and prevention of geological disasters are progressing smoothly. Langshan has been successfully applied for heritage, and the forest coverage rate has remained above 57%, and **the air quality in 14 cities and prefectures all reached the national second-level standards**.

3.2 Targets for 2013:

Initiate the comprehensive management of the Hengshao Arid Corridor, speed up the expansion of the Xiantianhe Reservoir; continue to strengthen the comprehensive management of the "four rivers" basin, dredging of navigation channels and river courses; promote the reinforcement of dikes and the renovation of large irrigation and drainage pumping stations. For urban construction, focus on promoting the Changsha subway and river-crossing tunnels, improving the main roads, water supply and drainage systems of cities and prefectures, comprehensively promoting the quality improvement of water supply facilities, and speeding up the construction of sewage treatment facilities and pipeline networks. Ecological construction, and strive to complete the investment of 45 billion yuan. **Accelerate ecological protection and restoration with "one lake, three mountains and four rivers" as the core, and promote the construction of Dongjiang Lake, Shuifu Temple water environmental protection** and management, and Qingshuitang ecological new city.

Deepen the construction of the Changsha-Zhuzhou-Xiangtan "resource-saving and environment-friendly society" pilot zone. Continue to implement ten key reforms such as industrial transformation and upgrading, joint property rights trading platforms, promote green credit, environmental liability insurance, and explore the issuance of Xiangjiang governance bonds. The implementation of eight major projects with the revitalization of the resource-saving and environment-friendly of industries as the main content, the in-depth promotion of the Xiangjiang River heavy metal pollution control, the comprehensive improvement of the rural environment and other ten environmental protection projects, focusing on the promotion of the Xiangjiang River Scenic Belt and the Zhaoshan Green Center protection and development of ten landmark projects. Speed up the construction of eighteen areas in five districts, start the relocation of key polluting enterprises, shut down and eliminate serious polluting enterprises and production lines according to law; promote the demonstration of heavy metal contaminated soil remediation. Improve the two-type

supervision system, establish a resource-saving and environment-friendly society construction statistical system, and carry out green GDP evaluation; promote the construction of two-type standards and implement resource-saving and environment-friendly label certification.

Do not relax energy saving and emission reduction work. Insist on saving priority. Continue to promote special energy-saving and emission-reduction technology initiatives, promote ten low-carbon clean technologies; promote energy-saving technological transformation focusing on energy-intensive industries such as power, coal, steel, nonferrous metals, chemicals, building materials, and promote clean production contract energy management; resolutely eliminate outdated production capacity, and strictly control new industries with high energy consumption, high emissions and overcapacity. Implement green building actions to improve building energy efficiency standards. Speed up the promotion of emission reduction projects focusing on the treatment of urban sewage and garbage, and the treatment of heavy metal pollution, and comprehensively promote the desulfurization and denitrification of thermal power, steel, cement and other industries. Extensively carry out the "Energy-saving and Low-Carbon Action for Ten Thousand Enterprises", focusing on the circular economy pilot work in Miluo and Yongxing. Accelerate the improvement of institutional mechanisms and policy systems for energy conservation and emission reduction, implement market-oriented mechanisms such as franchising operations of pollution control facilities, and in-depth promotion of emissions trading and ecological compensation pilot projects. Promote government green procurement.

Promote the ecological space with beautiful mountains and rivers and the intensive and efficient production space. vigorously promote the development of green Hunan, and ensure that the people drink clean water, breathe fresh air, and eat assured food. Insist on protection first. Continue to do a good job in planting afforestation, closing hills for afforestation, consolidating the results of returning farmland to forests and returning farmland to lakes, increase protection and restoration of water systems, woodlands, wetlands, scenic spots and ecologically fragile areas, maintain biodiversity, and prevent the invasion of alien species ; Carry out "Ten Green Forestry Actions" and accelerate the construction of Qingyang Lake Ecological and Cultural Demonstration Park. **Implement the most stringent water resources management system and promote the pilot project of building a national water-saving society.** Insist on natural restoration, strengthen the prevention and control of geological disasters in key areas, prevent and control rural non-point source pollution, and expand the scope of integrated comprehensive management of rural environments. Accelerate the construction of major functional zones, implement differentiated fiscal, investment, industrial, and land policies to build a scientific and rational pattern of urbanization, agricultural development, and ecological security. Implement the most stringent system for economical and intensive land use, establish and improve a performance evaluation mechanism for economical and intensive land use, and promote land-saving urban construction models and industrial development models. Strengthen environmental monitoring, supervision and emergency response capacity building.

Promote livable and moderate living space. Advocate and practice the ecological civilization concept of respecting, conforming to and protecting nature. Improve and implement energy-saving, water-saving, and environmentally-friendly product consumption

policies, and carry out in-depth activities to create “resource-saving and environment-friendly” agencies, parks, enterprises, villages, and households, and gradually form “resource-saving and environment-friendly” production methods, lifestyles, and consumption patterns. Strengthen the establishment of an ecological civilization system, explore the establishment of an ecological environment compensation mechanism, and improve the accountability system for ecological environmental protection and the environmental damage compensation system.

4. Work report of Hunan Provincial Government in 2014

4.1 Summary of 2013:

The pace of building a resource-saving and environment-friendly society is accelerating. The comprehensive management of the Xiangjiang River Basin, resource product prices and financial reforms have been recognized and promoted by relevant state departments. Take the lead in implementing civil tiered water, electricity, and gas price reforms, and pioneer the government procurement system for resource-saving and environment-friendly of products. The scope of the pilot program for paid use and trading of emission rights has been extended to all industrial enterprises in the eight cities in the Xiangjiang River Basin and thermal power and steel enterprises across the province. Comprehensive improvement of the rural environment has been fully implemented. **Solve the problem of drinking water safety for more than 3.7 million rural people. The protection and treatment of Xiangjiang River was listed as the “No. 1 Key Project” of the provincial government,** 228 heavy metal pollution control projects were newly launched, and 127 heavy metal pollution enterprises were shut down and eliminated. The construction of the intercity railway in Changsha, Zhuzhou and Xiangtan and the comprehensive hub of Xiangjiang in Changsha has been accelerated. Complete annual energy saving and emission reduction tasks. Ecological construction has been accelerated, the forest coverage rate has stabilized at more than 57%, and wetland protection has been further strengthened.

4.2 Targets for 2014:

Accelerate the comprehensive reform and construction of the Changsha-Zhuzhou-Xiangtan resource-saving and environment-friendly society pilot zone. Continue to promote the ten major reforms of the Changsha-Zhuzhou-Xiangtan Experimental Zone and promote the ten major clean and low-carbon technologies. Promote urban and rural coordination, land management, administrative management, financial management and other systems and mechanism innovations, focusing on land space use rights confirmation and registration, government management innovation, and evaluation and evaluation system reforms. Build integrated cross-regional projects such as infrastructure and environmental management of the Changsha-Zhuzhou-Xiangtan urban agglomeration, and strengthen the protection of ecological green core areas. Speed up the remediation of key polluted areas such as Shuikou Mountain in Hengyang, Qingshui Pond in Zhuzhou, Zhubu Port in Xiangtan, and Tin Mine in Loudi. Plan to cultivate new growth poles such as the Xiangjiang New Area.

Vigorously promote energy conservation and emission reduction. Research and introduce non-residents over-plans, over-quota water, electricity, and gas methods, and increase the implementation of differential electricity prices and direct power supply by enterprises. Accelerate the transformation of energy-saving technology and the construction of projects that eliminate outdated production capacity, and strive to complete the

construction of denitrification facilities for enterprises in the thermal power, cement, steel, petrochemical, and non-ferrous industries. Efforts will be made to promote energy conservation and consumption reduction in industries, construction, transportation, public institutions and residents' lives. Vigorously develop contract energy management. Promote the pilot reform of environmental pollution liability insurance and environmental service industry, and expand the scope of paid use and trading of pollution rights. Further improve the supporting facilities of urban sewage treatment plants and landfills, strengthen the supervision of the operation of environmental protection facilities, and promote the marketization of the operation of environmental protection facilities.

Fully promote the protection and management of Xiangjiang River and other key ecological and environmental protection work. **Focusing on clearer water, promptly implement the first "Three-Year Action Plan" of the Provincial Government's "No. 1 Key Project"**. Straighten out the management system of the Xiangjiang River Basin and fully implement the integration of water affairs in the Changsha-Zhuzhou-Xiangtan area. **Emphasize the protection of important water conservation areas, drinking water source areas and key soil erosion prevention and protection areas.** Focusing on making the mountains greener, vigorously promote the restoration of mountains, the management of tailings ponds, and the "recovering of green mines". Establish and improve the working mechanism of soil environmental protection, and launch pilot projects for the restoration and utilization of heavily contaminated farmland and crop structure adjustment. **Focusing on the bluer sky, increase the intensity of haze prevention and control, investment and policies, and promote the control of air pollution in key industries and regions.** Improve the joint prevention and control mechanism and monitoring network of air pollution in Changsha-Zhuzhou-Xiangtan area, and start the construction of air monitoring networks in other cities, prefectures, and key industrial and mining cities in batches. Strengthen the control of automobile exhaust, promote new energy vehicles, and implement green label management for all motor vehicles. Increase dust management on construction sites.

Strengthen the construction of ecological civilization system. Implement the national ecological compensation mechanism, and implement the most stringent source protection system, damage compensation system, and accountability system. Improve the promotion mechanism of green Hunan construction, and continue to do a good job in the construction of ecological cities, towns and villages. Vigorously plant trees and afforestation to develop the under-forest economy. Improve the property rights system of natural resources and assets, implement a system of paid use of resources, and accelerate the price reform of natural resources and their products. Implement the most stringent arable land protection system and land conservation system, strict use control, and strengthen land saving assessment. **Implement the most stringent water resources management system, establish and improve the "three red lines" indicator system and evaluation mechanism for total water use control, water use efficiency control, and water function zone limit pollution control.** Improve weather, geological, and earthquake disaster defense capabilities.

5. Work report of Hunan Provincial Government in 2015

5.1 Summary of 2014:

Ecological construction has increased. **The Provincial Government's "No. 1 Key Project" for**

the protection and management of the Xiangjiang River has completed the annual goal. The Zhubu Port area of Xiangtan took the lead in realizing the closure of all heavy chemical enterprises. The province eliminated 1147 heavy-duty enterprises, withdrew from large-scale breeding, and demolished 1351. With 679,000 square meters, the water quality of the Xiangjiang River continued to improve. The air pollution joint prevention and control mechanism has been established and perfected, and the thermal power generation unit and the new dry cement production line of 300,000 kilowatts or more have completed the construction of desulfurization and denitrification facilities. Remediation of heavy metal pollution in soil has been intensified, and pilot projects for remediation of heavy metal contaminated farmland and adjustment of crop planting structure have been launched. Complete the annual energy saving and emission reduction targets and tasks. Basically, establish responsibility, governance and supervision mechanisms for ecological protection and construction. Initiate a pilot program for unified registration of natural ecological spaces and delineation of ecological red lines. 28 counties (cities, districts) have carried out county-level and comprehensive improvement of the rural environment. The forest coverage rate has stabilized above 57%, and the wetland protection rate has reached 69.3%.

5.2 Targets for 2015:

Pollution prevention and control shall be carried out in a multi-pronged manner. Intensify water pollution control, and fully complete the first "Three-Year Action Plan" of the Provincial Government's "No. 1 Key Project" for the protection and control of the Xiangjiang River. Strengthen the prevention and control of industrial waste water, domestic sewage, aquaculture pollution and other sources, implement the harmless disposal and resource utilization of domestic waste. Increase pollution control in Zhuzhou Qingshuitang, Xiangtan Zhubu Port, Hengyang Shuikou Mountain, Chenzhou 36 Bay, Loudi Tin Mine, and Shaoyang Longxutang and other key areas. Vigorously promote the control of smog, reduce the intensity of industrial pollutant emissions, strictly control construction sites and road dust, and promote clean energy and new energy vehicles. Improve the ability of urban pollutants to diffuse and absorb, and do a good job in the prevention and control of air pollution in key areas such as Changsha, Zhuzhou and Xiangtan. Complete the "Twelfth Five-Year Plan" for the prevention and control of heavy metal pollution, and continue to implement pilot projects for the restoration of heavy metal contaminated farmland and the adjustment of crop planting structure.

Persistently promote energy conservation and emission reduction. Strengthen the dual control of total energy consumption and intensity, and develop green energy in accordance with local conditions. Give prominence to separate industry policies and reduction adjustments, and strictly implement energy-saving, land-saving and water-saving, environmental, technology, and safety market access standards. Resolutely eliminate outdated production capacity, resolve excess production capacity, and curb blind expansion of production capacity. Speed up the construction of sewage and garbage treatment facilities and supporting pipeline networks, and strengthen the daily operation and supervision of pollution control facilities. Promote the development of circular economy and comprehensive utilization of resources, promote energy-saving transformation and industrialization of energy-saving technology products. Support the development of environmental protection enterprises and cultivate environmental protection industry clusters.

Persistently strengthen the construction of ecological civilization. Complete the second phase of the reform of the Changsha-Zhuzhou-Xiangtan resource-saving and environment-friendly experimental zone. Speed up the price reform of natural resources and their products. Fully promote the paid use and trading of pollution rights, and **explore the establishment of a water rights trading system**. Establish and improve the ecological compensation mechanism. Promote the pilot demonstration of "one city, two counties and one area" as the main functional area, and build the Wuling mountain area and the ecological civilization demonstration area at the source of Xiangjiang River. **Implement the most stringent** farmland protection, conservation and intensive land use, and **water resources management systems**. Unified protection and unified management of mountains, rivers, forests, fields and lakes, restoration and management of mine ecology. The landscape, forest, field and lake should be protected, managed and restored. Implement logging bans and restrictions in key ecologically sensitive areas, and promote the restoration of bare mountains. Strengthen the construction and certification of the resource-saving and environment-friendly standard system, improve the monitoring and supervision mechanism for energy conservation and environmental protection, and implement accountability for major environmental issues. Advocate the concept of ecological civilization and promote a low-carbon lifestyle.