6. Comparison of Pollutant Emission Level in the World (1)

Nation		Area (1,000km2)	Population [Million]		Density [1,000Men/km2]		Net GDP BilUS$		GDP/Capita US$/Men		Primary Energy Cons [Mtoe]		PEC/Capita [kg-oe/Men]		PEC/km2 [kg-oe/km2]	
			1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987
a	(USA)	9,372.60	215.97	243.94	23.04	26.03	1,519.89	4,528.59	7,037	18,564	1,646.70	1,847.80	7,625	7,575	176	197
b	(Can)	9,976.10	22.73	25.64	2.28	2.57	158.10	389.59	6,956	15,192	161.10	201.70	7,088	7,865	16	20
c	(U.K.)	244.90	56.22	56.93	229.54	232.46	211.70	599.80	3,766	10,536	201.90	209.00	3,592	3,671	824	853
d	(Nl.)	37.30	13.67	14.67	366.38	393.16	78.55	172.83	5,748	11,785	59.90	65.40	4,383	4,460	1,606	1,753
e	(Swe)	450.00	8.19	8.40	18.20	18.66	66.83	130.45	8,158	15,533	39.50	48.80	4,822	5,811	88	108
f	(Germany)	248.60	61.83	61.08	248.71	245.68	412.48	883.51	6,671	14,465	239.10	272.70	3,867	4,465	962	1,097
g	(France)	551.50	52.70	55.63	95.56	100.87	314.08	718.10	5,960	12,909	162.20	209.30	3,078	3,762	294	380
h	Japan	377.80	111.94	122.26	296.29	323.62	496.26	1,933.53	4,433	15,814	307.40	365.70	2,746	2,991	814	968
	Dev Total	21,636.60	543.24	588.55	25.11	27.20	3,257.89	9,356.39	5,997	15,897	2,817.80	3,220.40	5,187	5,472	130	149
	Iran	**1,638.10**	**35.09**	**51.30**	**21.38**	**31.32**	**55.51**	**146.78**	**1,585**	**2,861**	**31.89**	**58.63**	**910**	**1,143**	**19**	**36**
	Prov. Tehran	19.13	6.79	9.04	354.80	472.62	10.75	30.16	1,585	3,336	6.18	10.33	910	1,143	323	540
	City Tehran	5.03	4.71	6.27	935.17	1,245.72	7.46	20.92	1,585	3,336	4.29	7.17	910	1,143	851	1,424
	Total Asia	21,330.75	2,224.16	2,751.21	104.27	128.98	929.06	3,072.79	418	1,117	1,035.10	1,628.90	465	592	49	76
1	China	9,564.00	933.00	1,088.57	97.55	113.82	184.65	319.91	198	294	354.65	648.65	380	596	37	68
2	Japan	377.80	111.94	122.26	296.29	323.62	496.26	1,933.53	4,433	15,814	326.42	371.66	2,916	3,040	864	984
3	India	3,287.20	600.76	781.37	182.76	237.70	85.96	247.88	143	317	145.08	228.51	241	292	44	70
4	Indonesia	1,904.60	130.50	170.18	68.52	89.35	29.12	76.22	223	448	37.67	67.90	289	399	20	36
5	Korea	99.00	35.28	41.58	356.36	420.00	19.85	121.93	563	2,932	27.27	66.06	773	1,589	275	667
6	North Korea	120.50	15.85	21.39	131.54	177.51	7.10	15.00	448	701	29.32	42.07	1,850	1,967	243	349
7	Taiwan	36.00	16.15	19.67	448.61	546.39	15.29	103.62	947	5,268	15.07	37.80	933	1,922	419	1,050
8	Thailand	513.10	41.87	53.61	81.60	104.48	14.60	45.66	349	852	18.58	30.46	444	568	36	59
9	Pakistan	796.10	71.03	102.24	89.22	128.43	11.27	34.43	159	337	13.26	28.67	187	280	17	36
10	Philippines	300.00	42.07	57.36	140.23	191.20	15.93	34.59	379	603	17.65	20.46	420	357	59	68
11	Malaysia	329.70	11.93	16.53	36.18	50.14	9.34	30.14	783	1,823	7.61	17.86	638	1,080	23	54
12	Bangladesh	144.00	78.96	102.56	548.33	712.22	7.28	17.43	92	170	6.76	10.70	86	104	47	74
13	Viet Nam	331.70	47.61	62.81	143.53	189.36	4.70	7.14	99	114	10.14	10.48	213	167	31	32
14	Hong Kong	1.05	4.40	5.61	4,210.53	5,368.42	7.70	34.59	1,750	6,166	4.25	9.15	966	1,631	4,067	8,756
15	Singapore	0.62	2.26	2.61	3,656.96	4,223.30	5.51	20.94	2,438	8,022	4.17	8.58	1,845	3,287	6,748	13,883
16	Nepal	140.80	12.59	17.79	89.42	126.35	1.34	2.84	106	160	2.88	8.19	229	460	20	58
17	Myanmar	676.50	30.17	39.14	44.60	57.86	3.32	10.33	110	264	4.58	5.92	152	151	7	9
18	Sri Lanka	65.60	13.50	16.36	205.79	249.39	3.54	6.66	262	407	2.73	3.69	202	226	42	56
19	Afghanistan	652.10	11.78	15.22	18.06	23.34	2.06	2.98	175	196	2.67	3.33	227	219	4	5
20	Mongolia	1,566.50	1.42	2.03	0.91	1.30	1.25	2.57	880	1,266	1.53	3.01	1,077	1,483	1	2
	Total Asia	21,330.75	2,224.16	2,751.21	104.27	128.98	929.06	3,072.79	418	1,117	1,035.10	1,628.90	465	592	49	76

Source: OECD, 1993, and others

6. Comparison of Pollutant Emission Level in the World (2)

	SOx (as SO2)										NOx (as NO2)									
	1,000t/y		kg/Capita		t/km2		kg/toe		kg/$1000		1,000t/y		kg/Capita		t/km2		kg/toe		kg/$1000	
	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987
a	25,440.0	20,940.0	117.79	85.84	2.71	2.23	15.4	11.3	16.7	4.6	20,030.0	18,750.0	92.74	76.86	2.14	2.00	12.2	10.1	13.2	4.1
b	5,318.0	3,798.0	233.99	148.10	0.53	0.38	33.0	18.8	33.6	9.7	1,740.0	1,942.2	76.56	75.74	0.17	0.19	10.8	9.6	11.0	5.0
c	5,367.0	3,897.0	95.47	68.45	21.92	15.91	26.6	18.6	25.4	6.5	2,245.0	2,603.0	39.94	45.72	9.17	10.63	11.1	12.5	10.6	4.3
d	427.0	261.0	31.25	17.80	11.45	7.00	7.1	4.0	5.4	1.5	482.0	587.0	35.27	40.03	12.92	15.74	8.0	9.0	6.1	3.4
e	686.0	221.0	83.74	26.32	1.52	0.49	17.4	4.5	10.3	1.7	308.0	431.0	37.60	51.32	0.68	0.96	7.8	8.8	4.6	3.3
f	3,334.0	1,933.0	53.92	31.65	13.41	7.78	13.9	7.1	8.1	2.2	2,530.0	2,902.0	40.92	47.51	10.18	11.67	10.6	10.6	6.1	3.3
g	3,328.0	1,261.0	63.15	22.67	6.03	2.29	20.5	6.0	10.6	1.8	1,608.0	1,407.0	30.51	25.29	2.92	2.55	9.9	6.7	5.1	2.0
h	2,496.2	827.3	22.30	6.77	6.61	2.19	8.1	2.3	5.0	0.4	1,738.0	1,177.7	15.53	9.63	4.60	3.12	5.7	3.2	3.5	0.6
	46,396.2	33,138.3	85.41	56.31	2.14	1.53	16.5	10.3	14.2	3.5	30,681.0	29,799.9	56.48	50.63	1.42	1.38	10.9	9.3	9.4	3.2
i	496.5	1,150.8	14.18	22.43	0.30	0.70	15.6	19.6	8.9	7.8	250.2	568.3	7.14	11.08	0.15	0.35	7.8	9.7	4.5	3.9
	96.19	202.76	14.18	22.43	5.03	10.60	15.6	19.6	8.9	6.7	48.47	100.13	7.14	11.08	2.53	5.24	7.8	9.7	4.5	3.3
	66.72	140.64	14.18	22.43	13.26	27.94	15.6	19.6	8.9	6.7	33.62	69.45	7.14	11.08	6.68	13.80	7.8	9.7	4.5	3.3
	18,341.8	29,145.6	8.25	10.59	0.86	1.37	17.7	17.9	19.7	9.5	9,461.3	15,492.0	4.25	5.63	0.44	0.73	9.1	9.5	10.2	5.0
1	10,175.0	19,989.0	10.91	18.36	1.06	2.09	28.7	30.8	55.1	62.5	3,727.0	7,370.0	3.99	6.77	0.39	0.77	10.5	11.4	20.2	23.0
2	2,571.0	1,144.0	22.97	9.36	6.81	3.03	7.9	3.1	5.2	0.6	2,330.0	1,935.0	20.81	15.83	6.17	5.12	7.1	5.2	4.7	1.0
3	1,652.0	3,074.0	2.75	3.93	0.50	0.94	11.4	13.5	19.2	12.4	1,378.0	2,556.0	2.29	3.27	0.42	0.78	9.5	11.2	16.0	10.3
4	201.0	485.0	1.54	2.85	0.11	0.25	5.3	7.1	6.9	6.4	331.0	639.0	2.54	3.75	0.17	0.34	8.8	9.4	11.4	8.4
5	1,160.0	1,294.0	32.88	31.12	11.72	13.07	42.5	19.6	58.4	10.6	221.0	555.0	6.26	13.35	2.23	5.61	8.1	8.4	11.1	4.6
6	234.0	333.0	14.76	15.57	1.94	2.76	8.0	7.9	33.0	22.2	326.0	468.0	20.57	21.88	2.71	3.88	11.1	11.1	45.9	31.2
7	609.0	604.0	37.71	30.71	16.92	16.78	40.4	16.0	39.8	5.8	124.0	324.0	7.68	16.47	3.44	9.00	8.2	8.6	8.1	3.1
8	224.0	611.0	5.35	11.40	0.44	1.19	12.1	20.1	15.3	13.4	181.0	392.0	4.32	7.31	0.35	0.76	9.7	12.9	12.4	8.6
9	148.0	382.0	2.08	3.74	0.19	0.48	11.2	13.3	13.1	11.1	173.0	230.0	2.44	2.25	0.22	0.29	13.0	8.0	15.4	6.7
10	807.0	371.0	19.18	6.47	2.69	1.24	45.7	18.1	50.7	10.7	172.0	184.0	4.09	3.21	0.57	0.61	9.7	9.0	10.8	5.3
11	193.0	263.0	16.18	15.91	0.59	0.80	25.4	14.7	20.7	8.7	89.0	178.0	7.46	10.77	0.27	0.54	11.7	10.0	9.5	5.9
12	39.0	49.0	0.49	0.48	0.27	0.34	5.8	4.6	5.4	2.8	46.0	67.0	0.58	0.65	0.32	0.47	6.8	6.3	6.3	3.8
13	41.0	39.0	0.86	0.62	0.12	0.12	4.0	3.7	8.7	5.5	120.0	100.0	2.52	1.59	0.36	0.30	11.8	9.5	25.5	14.0
14	108.0	150.0	24.55	26.74	103.35	143.54	25.4	16.4	14.0	4.3	50.0	133.0	11.36	23.71	47.85	127.27	11.8	14.5	6.5	3.8
15	85.0	156.0	37.61	59.77	137.54	252.43	20.4	18.2	15.4	7.5	44.0	88.0	19.47	33.72	71.20	142.39	10.6	10.3	8.0	4.2
16	4.0	12.0	0.32	0.67	0.03	0.09	1.4	1.5	3.0	4.2	18.0	51.0	1.43	2.87	0.13	0.36	6.3	6.2	13.4	17.9
17	18.0	31.0	0.60	0.79	0.03	0.05	3.9	5.2	5.4	3.0	38.0	45.0	1.26	1.15	0.06	0.07	8.3	7.6	11.4	4.4
18	22.0	29.0	1.63	1.77	0.34	0.44	8.1	7.9	6.2	4.4	22.0	37.0	1.63	2.26	0.34	0.56	8.1	10.0	6.2	5.6
19	8.1	10.7	0.69	0.70	0.01	0.02	3.0	3.2	3.9	3.6	20.0	29.4	1.70	1.93	0.03	0.05	7.5	8.8	9.7	9.9
20	38.7	100.5	27.25	49.51	0.02	0.06	25.3	33.4	31.0	39.1	30.8	72.1	21.69	35.52	0.02	0.05	20.1	24.0	24.6	28.1
	18,341.8	29,145.6	8.25	10.59	0.86	1.37	17.7	17.9	19.7	9.5	9,461.3	15,492.0	4.25	5.63	0.44	0.73	9.1	9.5	10.2	5.0

Source: OECD, 1993, and others

6. Comparison of Pollutant Emission Level in the World (3)

	CO2 (as C)										PEC/GDP	
	1,000t/y		kg/Capita		t/km2		kg/toe		kg/$1000		toe/$1000	
	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987
a	1,242,330	1,350,957	6,255.2	5,092.7	144.1	132.5	754.4	731.1	817.4	298.3	1.083	0.408
b	106,009	120,305	4,664.5	4,691.3	10.6	12.1	658.0	596.5	670.5	308.8	1.019	0.518
c	173,015	164,308	3,077.7	2,886.1	706.5	670.9	856.9	786.2	817.3	273.9	0.954	0.348
d	46,791	51,632	3,423.9	3,520.8	1,254.4	1,384.2	781.2	789.5	595.7	298.7	0.763	0.378
e	23,058	17,861	2,814.6	2,126.8	51.2	39.7	583.7	366.0	345.0	136.9	0.591	0.374
f	210,221	203,080	3,400.0	3,325.0	845.6	816.9	879.2	744.7	509.7	229.9	0.580	0.309
g	129,327	119,102	2,454.1	2,141.0	234.5	216.0	797.3	569.1	411.8	165.9	0.516	0.291
h	238,309	282,201	2,128.9	2,308.1	630.8	747.0	775.2	771.7	480.2	146.0	0.619	0.189
	2,169,061	2,309,447	3,992.8	3,924.0	100.2	106.7	769.8	717.1	665.8	246.8	0.865	0.344
	19,593	44,444	559.4	866.3	12.0	27.1	614.4	758.0	353.0	302.8	0.574	0.399
	3,796	7,831	559.4	866.3	198.5	409.5	614.4	758.0	353.0	259.7	0.574	0.343
	2,633	5,432	559.4	866.3	523.1	1,079.2	614.4	758.0	353.0	259.7	0.574	0.343
	982,669	1,480,992	441.8	538.3	46.1	69.4	949.3	909.2	1,057.7	482.0	1.114	0.530
1	356,802	648,908	382.4	596.1	37.3	67.8	1,006.1	1,000.4	1,932.3	2,028.4	1.921	2.028
2	271,945	271,785	2,429.4	2,222.9	719.8	719.4	833.1	731.3	548.0	140.6	0.658	0.192
3	146,754	219,278	244.3	280.6	44.6	66.7	1,011.5	959.6	1,707.2	884.6	1.688	0.922
4	39,629	68,094	303.7	400.1	20.8	35.8	1,052.0	1,002.9	1,360.9	893.4	1.294	0.891
5	27,063	54,821	767.1	1,318.4	273.4	553.7	992.4	829.9	1,363.4	449.6	1.374	0.542
6	29,247	40,181	1,845.2	1,878.5	242.7	333.5	997.5	955.1	4,119.3	2,678.7	4.130	2.805
7	11,962	26,336	740.7	1,338.9	332.3	731.6	793.8	696.7	782.2	254.2	0.985	0.365
8	20,986	32,181	501.2	600.3	40.9	62.7	1,129.5	1,056.5	1,437.4	704.7	1.273	0.667
9	10,518	20,455	148.1	200.1	13.2	25.7	793.2	713.5	933.3	594.2	1.177	0.833
10	17,235	18,387	409.7	320.6	57.5	61.3	976.5	898.7	1,081.9	531.6	1.108	0.592
11	6,633	12,338	572.8	746.4	20.7	37.4	897.9	690.8	731.6	409.4	0.815	0.593
12	7,210	9,707	91.3	94.6	50.1	67.4	1,066.6	907.2	990.4	556.8	0.929	0.614
13	10,521	11,253	221.0	179.2	31.7	33.9	1,037.6	1,073.8	2,238.5	1,576.1	2.157	1.468
14	3,638	9,390	826.8	1,673.8	3,481.3	8,985.6	856.0	1,026.2	472.5	271.5	0.552	0.265
15	3,531	6,414	1,562.4	2,457.5	5,713.6	10,378.6	846.8	747.6	640.8	306.3	0.757	0.410
16	3,374	9,546	268.0	536.6	24.0	67.8	1,171.5	1,165.6	2,517.9	3,357.7	2.149	2.881
17	5,104	6,618	169.2	169.1	7.5	9.8	1,114.4	1,117.9	1,537.3	641.0	1.380	0.573
18	2,667	3,472	197.6	212.2	40.7	52.9	976.9	940.9	753.4	521.2	0.771	0.554
19	2,817	3,212	239.2	211.0	4.3	4.9	1,055.1	964.5	1,367.6	1,077.8	1.296	1.117
20	1,655	3,213	1,165.5	1,582.8	1.1	2.1	1,081.7	1,067.4	1,324.0	1,250.2	1.224	1.171
	982,669	1,480,992	441.8	538.3	46.1	69.4	949.3	909.2	1,057.7	482.0	1.114	0.530

Source: OECD, 1993, and others

6. Comparison of Pollutant Emission Level in the World (4)

	Nation	SOx						NOx						CO2					
		1,000t/y		kg/Capita		t/km2		1,000t/y		kg/Capita		t/km2		1,000t-C/y		kg/Capita		t/km2	
		1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987
a	(USA)	640.0	890.0	2.96	3.65	0.07	0.09	10,020.0	8,140.0	46.39	33.37	1.07	0.87	322,330	388,299	1,797.9	1,321.3	41.4	34.4
b	(Can)	113.0	95.0	4.97	3.70	0.01	0.01	1,134.0	1,198.0	49.90	46.72	0.11	0.12	29,191	33,459	1,284.4	1,304.7	2.9	3.4
c	(U.K.)	150.0	97.0	2.67	1.70	0.61	0.40	885.0	1,304.0	15.74	22.91	3.61	5.32	28,018	35,212	498.4	618.5	114.4	143.8
d	(Nl.)	41.0	36.0	3.00	2.45	1.10	0.97	258.0	338.0	18.88	23.05	6.92	9.06	13,933	17,085	1,019.6	1,165.0	373.5	458.0
e	(Swe)	19.0	40.0	2.32	4.76	0.04	0.09	195.0	339.0	23.80	40.37	0.43	0.75	5,136	6,062	627.0	721.8	11.4	13.5
f	(Germany)	133.0	90.0	2.15	1.47	0.53	0.36	1,308.0	1,830.0	21.16	29.96	5.26	7.36	31,064	40,381	502.4	661.1	125.0	162.4
g	(France)	103.0	120.0	1.95	2.16	0.19	0.22	857.0	980.0	16.26	17.62	1.55	1.78	24,976	33,721	473.9	606.2	45.3	61.1
h	Japan	108.0	166.0	0.97	1.36	0.29	0.44	805.0	518.0	7.22	4.24	2.13	1.37	46,212	62,093	414.4	508.6	122.3	164.4
	Dev Total	1,307.0	1,534.0	2.41	2.61	0.06	0.07	15,462.0	14,647.0	28.48	24.89	0.71	0.68	500,861	616,312	922.7	1,047.5	23.1	28.5
	Iran	**75.3**	**196.1**	**2.15**	**3.82**	**0.05**	**0.12**	**127.4**	**323.2**	**3.64**	**6.30**	**0.08**	**0.20**	**4,096**	**9,755**	**117.0**	**190.2**	**2.5**	**6.0**
	Prov. Tehran	14.58	34.56	2.15	3.82	0.76	1.81	24.68	56.95	3.64	6.30	1.29	2.98	794	1,719	117.0	190.2	41.5	89.9
	City Tehran	10.12	23.97	2.15	3.82	2.01	4.76	17.12	39.50	3.64	6.30	3.40	7.85	550	1,192	117.0	190.2	109.4	236.9
	Total Asia	1,088.5	1,634.6	0.49	0.59	0.05	0.08	2,720.3	3,886.4	1.22	1.41	0.13	0.18	85,289	138,385	38.4	50.3	4.0	6.5
1	China	379.0	581.0	0.41	0.53	0.04	0.06	374.0	683.0	0.40	0.63	0.04	0.07	15,561	24,550	16.7	22.6	1.6	2.6
2	Japan	223.0	254.0	2.00	2.08	0.59	0.67	1,274.0	1,197.0	11.42	9.80	3.37	3.17	34,569	49,832	309.8	408.2	91.5	131.9
3	India	294.0	372.0	0.49	0.48	0.09	0.11	355.0	618.0	0.59	0.79	0.11	0.19	14,682	20,645	24.4	26.4	4.5	6.3
4	Indonesia	19.0	42.0	0.15	0.25	0.01	0.02	108.0	229.0	0.83	1.35	0.06	0.12	3,293	6,962	25.2	40.9	1.7	3.7
5	Korea	50.0	107.0	1.42	2.57	0.51	1.08	72.0	272.0	2.04	6.54	0.73	2.75	2,112	8,012	59.9	192.7	21.3	80.9
6	North Korea	3.0	6.0	0.19	0.28	0.02	0.05	27.0	65.0	1.70	3.04	0.22	0.54	773	1,932	48.8	90.3	6.4	16.0
7	Taiwan	13.0	31.0	0.80	1.58	0.36	0.86	46.0	141.0	2.85	7.17	1.28	3.92	1,458	4,110	90.3	208.9	40.5	114.2
8	Thailand	18.0	79.0	0.43	1.47	0.04	0.15	77.0	206.0	1.84	3.84	0.15	0.40	2,594	6,701	62.0	125.0	5.1	13.1
9	Pakistan	27.0	64.0	0.38	0.63	0.03	0.08	120.0	120.0	1.69	1.17	0.15	0.15	1,382	3,724	19.5	36.4	1.7	4.7
10	Philippines	11.0	13.0	0.26	0.23	0.04	0.04	66.0	54.0	1.57	0.94	0.22	0.18	1,861	1,592	44.2	27.8	6.2	5.3
11	Malaysia	17.0	31.0	1.42	1.88	0.05	0.09	51.0	107.0	4.27	6.47	0.15	0.32	1,629	3,297	136.5	199.5	4.9	10.0
12	Bangladesh	4.0	8.0	0.05	0.08	0.03	0.06	8.0	16.0	0.10	0.16	0.06	0.11	194	416	2.5	4.1	1.3	2.9
13	Viet Nam	7.0	2.0	0.15	0.03	0.02	0.01	55.0	22.0	1.16	0.35	0.17	0.07	2,107	654	44.3	10.4	6.4	2.0
14	Hong Kong	5.0	8.0	1.14	1.43	4.78	7.66	24.0	37.0	5.45	6.60	22.97	35.41	898	1,603	204.1	285.7	859.3	1,534.0
15	Singapore	5.0	12.0	2.21	4.60	8.09	19.42	22.0	46.0	9.73	17.62	35.60	74.43	873	2,036	386.3	780.1	1,412.6	3,294.5
16	Nepal	0.0	1.0	0.00	0.06	0.00	0.01	1.0	2.0	0.08	0.11	0.01	0.01	27	57	2.1	3.2	0.2	0.4
17	Myanmar	5.0	4.0	0.17	0.10	0.01	0.01	12.0	11.0	0.40	0.28	0.02	0.02	384	345	12.7	8.8	0.6	0.5
18	Sri Lanka	5.0	10.0	0.37	0.61	0.08	0.15	11.0	21.0	0.81	1.28	0.17	0.32	360	687	26.7	42.0	5.5	10.5
19	Afghanistan	2.0	6.3	0.17	0.41	0.00	0.01	5.7	14.7	0.48	0.97	0.01	0.02	183	512	15.5	33.6	0.3	0.8
20	Mongolia	0.5	1.4	0.35	0.69	0.00	0.00	6.3	12.9	4.44	6.35	0.00	0.01	179	363	126.1	178.8	0.1	0.2
	Total Asia	1,088.5	1,634.6	0.49	0.59	0.05	0.08	2,720.3	3,886.4	1.22	1.41	0.13	0.18	85,289	138,385	38.4	50.3	4.0	6.5

Source: OECD, 1993, and others

6. Comparison of Pollutant Emission Level in the World (5)

	Nation	SOx						NOx						CO2					
		1,000t/y		kg/Capita		t/km2		1,000t/y		kg/Capita		t/km2		1,000t-C/y		kg/Capita		t/km2	
		1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987
a	(USA)	16,570.0	14,220.0	76.72	58.29	1.77	1.52	5,170.0	6,420.0	23.94	26.32	0.55	0.68	433,933	536,750	2,485.3	1,778.8	57.3	46.3
b	(Can)	610.0	810.0	26.84	31.59	0.06	0.08	216.0	264.8	9.50	10.33	0.02	0.03	25,539	36,917	1,123.7	1,439.6	2.6	3.7
c	(U.K.)	2,941.0	2,830.0	52.32	49.71	12.01	11.56	837.0	826.0	14.89	14.51	3.42	3.37	73,064	69,669	1,299.7	1,223.8	298.3	284.5
d	(Nl.)	29.0	62.0	2.12	4.23	0.78	1.66	59.0	83.0	4.32	5.66	1.58	2.23	11,894	14,821	870.3	1,010.7	318.9	397.4
e	(Swe)	66.0	11.0	8.06	1.31	0.15	0.02	18.0	6.0	2.20	0.71	0.04	0.01	2,930	3,102	357.7	369.3	6.5	6.9
f	(Germany)	1,757.0	1,154.0	28.42	18.89	7.07	4.64	657.0	661.0	10.63	10.82	2.64	2.66	80,306	78,917	1,298.8	1,292.1	323.0	317.4
g	(France)	976.0	271.0	18.52	4.87	1.77	0.49	229.0	89.0	4.35	1.60	0.42	0.16	31,418	24,895	596.2	447.5	57.0	45.1
h	Japan	751.3	179.3	6.74	1.47	1.99	0.47	286.1	181.3	2.57	1.49	0.76	0.48	79,800	106,944	715.6	875.9	211.2	283.1
	Dev Total	23,700.3	19,537.3	43.66	33.21	1.10	0.90	7,472.1	8,531.1	13.77	14.50	0.35	0.39	738,885	872,016	1,361.2	1,482.1	34.1	40.3
	Iran	134.9	336.4	3.85	6.56	0.08	0.21	50.1	93.0	1.43	1.81	0.03	0.06	2,989	7,996	85.3	155.9	1.8	4.9
	Prov. Tehran	26.14	59.28	3.85	6.56	1.37	3.10	9.71	16.39	1.43	1.81	0.51	0.86	579	1,409	85.3	155.9	30.3	73.7
	City Tehran	18.13	41.12	3.85	6.56	3.60	8.17	6.74	11.37	1.43	1.81	1.34	2.26	402	977	85.3	155.9	79.8	194.2
	Total Asia	5,469.5	10,354.5	2.46	3.76	0.26	0.49	2,122.5	4,740.8	0.95	1.72	0.10	0.22	219,738	384,639	98.8	139.8	10.3	18.0
1	China	2,473.0	6,493.0	2.65	5.96	0.26	0.68	957.0	2,533.0	1.03	2.33	0.10	0.26	56,229	144,652	60.3	132.9	5.9	15.1
2	Japan	829.0	274.0	7.43	2.24	2.19	0.73	410.0	248.0	3.67	2.03	1.09	0.66	105,310	107,839	943.9	883.3	278.7	285.4
3	India	620.0	1,521.0	1.03	1.95	0.19	0.46	356.0	1,016.0	0.59	1.30	0.11	0.31	20,903	57,763	34.8	73.9	6.4	17.6
4	Indonesia	131.0	309.0	1.00	1.82	0.07	0.16	60.0	173.0	0.46	1.02	0.03	0.09	3,455	10,772	26.5	63.3	1.8	5.7
5	Korea	451.0	247.0	12.78	5.94	4.56	2.49	53.0	110.0	1.50	2.65	0.54	1.11	5,582	8,808	158.2	211.8	56.4	89.0
6	North Korea	32.0	75.0	2.02	3.51	0.27	0.62	53.0	115.0	3.34	5.38	0.44	0.95	3,382	7,531	213.4	352.1	28.1	62.5
7	Taiwan	325.0	272.0	20.12	13.83	9.03	7.56	38.0	105.0	2.35	5.34	1.06	2.92	4,774	9,023	295.6	458.7	132.6	250.6
8	Thailand	103.0	367.0	2.46	6.85	0.20	0.72	49.0	112.0	1.17	2.09	0.10	0.22	7,652	12,663	182.8	236.2	14.9	24.7
9	Pakistan	27.0	89.0	0.38	0.87	0.03	0.11	12.0	34.0	0.17	0.33	0.02	0.04	1,366	3,219	19.2	31.5	1.7	4.0
10	Philippines	191.0	213.0	4.54	3.71	0.64	0.71	46.0	60.0	1.09	1.05	0.15	0.20	3,374	4,007	80.2	69.9	11.2	13.4
11	Malaysia	90.0	152.0	7.54	9.20	0.27	0.46	14.0	32.0	1.17	1.94	0.04	0.10	1,377	3,034	115.4	183.5	4.2	9.2
12	Bangladesh	9.0	20.0	0.11	0.20	0.06	0.14	4.0	11.0	0.05	0.11	0.03	0.08	334	1,285	4.2	12.5	2.3	8.9
13	Viet Nam	4.0	6.0	0.06	0.10	0.01	0.02	10.0	16.0	0.21	0.25	0.03	0.05	639	1,091	13.4	17.4	1.9	3.3
14	Hong Kong	78.0	98.0	17.73	17.47	74.64	93.78	18.0	83.0	4.09	14.80	17.22	79.43	1,547	5,634	351.6	1,004.3	1,480.4	5,391.4
15	Singapore	75.0	140.0	33.19	53.64	121.36	226.54	21.0	41.0	9.29	15.71	33.98	66.34	2,265	3,925	1,002.2	1,503.8	3,665.0	6,351.1
16	Nepal	0.0	1.0	0.00	0.06	0.00	0.01	0.0	1.0	0.00	0.06	0.00	0.01	8	21	0.6	1.2	0.1	0.1
17	Myanmar	4.0	7.0	0.13	0.18	0.01	0.01	5.0	4.0	0.17	0.10	0.01	0.01	744	281	24.7	7.2	1.1	0.4
18	Sri Lanka	5.0	11.0	0.37	0.67	0.08	0.17	1.0	5.0	0.07	0.31	0.02	0.08	121	465	9.0	28.4	1.8	7.1
19	Afghanistan	2.1	2.3	0.18	0.15	0.00	0.00	2.0	3.2	0.17	0.21	0.00	0.00	138	291	11.7	19.1	0.2	0.4
20	Mongolia	20.1	52.5	14.15	25.86	0.01	0.03	12.7	31.5	8.94	15.52	0.01	0.02	462	1,093	325.4	538.4	0.3	0.7
	Total Asia	5,469.5	10,354.5	2.46	3.76	0.26	0.49	2,122.5	4,740.8	0.95	1.72	0.10	0.22	219,738	384,639	98.8	139.8	10.3	18.0

Source: OECD, 1993, and others

6. Comparison of Pollutant Emission Level in the World (6)

	Nation	SOx						NOx						CO2					
		1,000t/y		kg/Capita		t/km2		1,000t/y		kg/Capita		t/km2		1,000t-C/y		kg/Capita		t/km2	
		1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987
a	(USA)	4,570.0	3,010.0	21.16	12.34	0.49	0.32	680.0	560.0	3.15	2.30	0.07	0.06	266,827	251,804	1,165.9	1,093.8	26.9	28.5
b	(Can)	3,715.0	2,593.0	163.46	101.12	0.37	0.26	36.0	88.0	1.58	3.43	0.00	0.01	25,548	27,439	1,124.1	1,070.0	2.6	2.8
c	(U.K.)	32.0	22.0	0.57	0.39	0.13	0.09	34.0	86.0	0.60	1.51	0.14	0.35	38,661	26,678	687.7	468.6	157.9	108.9
d	(Nl.)	101.0	49.0	7.39	3.34	2.71	1.31	37.0	29.0	2.71	1.98	0.99	0.78	9,270	7,517	678.3	512.6	248.5	201.5
e	(Swe)	230.0	61.0	28.08	7.26	0.51	0.14	22.0	22.0	2.69	2.62	0.05	0.05	6,448	4,272	787.2	508.7	14.3	9.5
f	(Germany)	101.0	98.0	1.63	1.60	0.41	0.39	40.0	24.0	0.65	0.39	0.16	0.10	47,288	40,267	764.8	659.3	190.2	162.0
g	(France)	475.0	188.0	9.01	3.38	0.86	0.34	94.0	139.0	1.78	2.50	0.17	0.25	40,521	30,335	768.9	545.3	73.5	55.0
h	Japan	1,528.6	453.0	13.71	3.71	4.05	1.20	631.0	463.3	5.66	3.80	1.67	1.23	81,552	76,850	731.3	629.5	215.9	203.4
	Dev Total	10,752.6	6,474.0	19.81	11.00	0.50	0.30	1,574.0	1,411.3	2.90	2.40	0.07	0.07	516,115	465,161	950.8	790.6	23.9	21.5
	Iran	**175.8**	**374.9**	**5.02**	**7.31**	**0.11**	**0.23**	**30.7**	**68.3**	**0.88**	**1.33**	**0.02**	**0.04**	**3,745**	**8,591**	**106.9**	**167.5**	**2.3**	**5.2**
	Prov. Tehran	34.07	66.06	5.02	7.31	1.78	3.45	5.94	12.03	0.88	1.33	0.31	0.63	725	1,514	106.9	167.5	37.9	79.1
	City Tehran	23.63	45.82	5.02	7.31	4.69	9.10	4.12	8.34	0.88	1.33	0.82	1.66	503	1,050	106.9	167.5	100.0	208.6
	Total Asia	7,838.4	10,996.7	3.52	4.00	0.37	0.52	3,106.7	4,808.9	1.40	1.75	0.15	0.23	324,860	461,371	146.1	167.7	15.2	21.6
1	China	4,865.0	8,228.0	5.21	7.56	0.51	0.86	1,820.0	3,265.0	1.95	3.00	0.19	0.34	155,705	274,153	166.9	251.8	16.3	28.7
2	**Japan**	**1,225.0**	**350.0**	**10.98**	**2.87**	**3.24**	**0.93**	**546.0**	**386.0**	**4.89**	**3.16**	**1.45**	**1.02**	**89,997**	**65,560**	**806.6**	**537.0**	**238.2**	**173.5**
3	India	541.0	886.0	0.90	1.13	0.16	0.27	278.0	461.0	0.46	0.59	0.08	0.14	27,296	37,949	45.4	48.6	8.3	11.5
4	Indonesia	16.0	64.0	0.12	0.38	0.01	0.03	16.0	40.0	0.12	0.24	0.01	0.02	2,374	7,786	18.2	45.8	1.2	4.1
5	Korea	390.0	371.0	11.05	8.92	3.94	3.75	44.0	101.0	1.25	2.43	0.44	1.02	6,082	16,107	172.4	387.4	61.4	162.7
6	North Korea	198.0	251.0	12.49	11.73	1.64	2.08	241.0	282.0	15.21	13.18	2.00	2.34	23,159	28,280	1,461.1	1,322.1	192.2	234.7
7	Taiwan	193.0	200.0	11.95	10.17	5.36	5.56	33.0	66.0	2.04	3.36	0.92	1.83	3,296	8,486	204.1	431.4	91.6	235.7
8	Thailand	73.0	146.0	1.74	2.72	0.14	0.28	19.0	39.0	0.45	0.73	0.04	0.08	3,396	4,824	81.1	90.0	6.6	9.4
9	Pakistan	43.0	207.0	0.61	2.02	0.05	0.26	14.0	41.0	0.20	0.40	0.02	0.05	1,821	4,900	25.6	47.9	2.3	6.2
10	Philippines	117.0	70.0	2.78	1.22	0.39	0.23	21.0	18.0	0.50	0.31	0.07	0.06	3,837	2,044	91.2	35.6	12.8	6.8
11	Malaysia	69.0	69.0	5.78	4.17	0.21	0.21	15.0	27.0	1.26	1.63	0.05	0.08	1,635	2,893	137.0	175.0	5.0	8.8
12	Bangladesh	19.0	7.0	0.24	0.07	0.13	0.05	5.0	5.0	0.06	0.05	0.03	0.03	782	930	9.9	9.1	5.4	6.5
13	Viet Nam	26.0	26.0	0.55	0.41	0.08	0.08	30.0	30.0	0.63	0.48	0.09	0.09	2,803	2,896	58.9	46.1	8.5	8.7
14	Hong Kong	21.0	43.0	4.77	7.66	20.10	41.15	7.0	12.0	1.59	2.14	6.70	11.48	815	1,521	185.2	271.1	779.9	1,455.5
15	Singapore	5.0	4.0	2.21	1.53	8.09	6.47	1.0	1.0	0.44	0.38	1.62	1.62	141	153	62.4	58.6	228.2	247.6
16	Nepal	1.0	1.0	0.08	0.06	0.01	0.01	0.0	1.0	0.00	0.06	0.00	0.01	37	75	2.9	4.2	0.3	0.5
17	Myanmar	6.0	16.0	0.20	0.41	0.01	0.02	4.0	5.0	0.13	0.13	0.01	0.01	517	943	17.1	24.1	0.8	1.4
18	Sri Lanka	10.0	6.0	0.74	0.37	0.15	0.09	3.0	3.0	0.22	0.18	0.05	0.05	596	616	44.1	37.7	9.1	9.4
19	Afghanistan	2.3	0.4	0.20	0.03	0.00	0.00	0.4	0.1	0.03	0.01	0.00	0.00	47	15	4.0	1.0	0.1	0.0
20	Mongolia	17.7	46.2	12.46	22.76	0.01	0.03	9.1	24.9	6.41	12.27	0.01	0.02	449	1,125	316.2	554.2	0.3	0.7
	Total Asia	7,838.4	10,996.7	3.52	4.00	0.37	0.52	3,106.7	4,808.9	1.40	1.75	0.15	0.23	324,860	461,371	146.1	167.7	15.2	21.6

Source: OECD, 1993, and others

6. Comparison of Pollutant Emission Level in the World (7)

	Nation	SOx						NOx						CO2					
		1,000t/y		kg/Capita		t/km2		1,000t/y		kg/Capita		t/km2		1,000t-C/y		kg/Capita		t/km2	
		1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987	1975	1987
a	(USA)	3,660.0	2,820.0	16.95	11.56	0.39	0.30	4,160.0	3,630.0	19.26	14.88	0.44	0.39	219,239	174,104	806.1	898.7	18.6	23.4
b	(Can)	860.0	300.0	38.72	11.70	0.09	0.03	354.0	391.4	15.58	15.26	0.04	0.04	25,730	22,490	1,132.1	877.0	2.6	2.3
c	(U.K.)	2,244.0	948.0	39.92	16.65	9.16	3.87	489.0	387.0	8.70	6.80	2.00	1.58	33,273	32,750	591.9	575.3	135.9	133.7
d	(Nl.)	256.0	114.0	18.73	7.77	6.86	3.06	128.0	137.0	9.37	9.34	3.43	3.67	11,694	12,208	855.7	832.5	313.5	327.3
e	(Swe)	371.0	109.0	45.29	12.98	0.82	0.24	73.0	64.0	8.91	7.62	0.16	0.14	8,542	4,426	1,042.8	527.0	19.0	9.8
f	(Germany)	1,343.0	591.0	21.72	9.68	5.40	2.38	525.0	387.0	8.49	6.34	2.11	1.56	51,564	43,515	834.0	712.5	207.4	175.0
g	(France)	1,774.0	682.0	33.66	12.26	3.22	1.24	428.0	199.0	8.12	3.58	0.78	0.36	32,412	30,151	615.0	542.0	58.8	54.7
h	Japan	108.3	29.0	0.97	0.24	0.29	0.08	15.9	15.0	0.14	0.12	0.04	0.04	30,745	36,315	275.7	297.4	81.4	96.1
	Dev Total	10,636.3	5,593.0	19.59	9.51	0.49	0.26	6,172.9	5,210.4	11.37	8.86	0.29	0.24	413,200	355,959	761.2	605.0	19.1	16.5
	Iran	110.5	243.3	3.15	4.74	0.07	0.15	42.0	83.8	1.20	1.63	0.03	0.05	8,763	18,101	250.2	352.8	5.3	11.0
	Prov. Tehran	21.40	42.86	3.15	4.74	1.12	2.24	8.14	14.77	1.20	1.63	0.43	0.77	1,698	3,189	250.2	352.8	88.8	166.8
	City Tehran	14.84	29.73	3.15	4.74	2.95	5.91	5.65	10.24	1.20	1.63	1.12	2.03	1,178	2,212	250.2	352.8	234.0	439.5
	Total Asia	3,945.4	6,159.8	1.77	2.24	0.18	0.29	1,511.8	2,055.9	0.68	0.75	0.07	0.10	352,781	496,597	158.6	180.5	16.5	23.3
1	China	2,458.0	4,687.0	2.63	4.31	0.26	0.49	576.0	889.0	0.62	0.82	0.06	0.09	129,307	205,553	138.6	188.8	13.5	21.5
2	**Japan**	294.0	266.0	2.64	2.18	0.78	0.70	100.0	104.0	0.90	0.85	0.26	0.28	42,069	48,554	377.1	397.7	111.4	128.5
3	India	197.0	295.0	0.33	0.38	0.06	0.09	389.0	461.0	0.65	0.59	0.12	0.14	83,873	102,921	139.6	131.7	25.5	31.3
4	Indonesia	35.0	70.0	0.27	0.41	0.02	0.04	147.0	197.0	1.13	1.16	0.08	0.10	30,507	42,574	233.8	250.2	16.0	22.4
5	Korea	269.0	569.0	7.62	13.68	2.72	5.75	52.0	72.0	1.47	1.73	0.53	0.73	13,287	21,894	376.6	526.6	134.2	221.2
6	North Korea	1.0	1.0	0.06	0.05	0.01	0.01	5.0	6.0	0.32	0.28	0.04	0.05	1,933	2,438	122.0	114.0	16.0	20.2
7	Taiwan	78.0	101.0	4.83	5.13	2.17	2.81	7.0	12.0	0.43	0.61	0.19	0.33	2,434	4,717	150.7	239.8	67.6	131.0
8	Thailand	30.0	19.0	0.72	0.35	0.06	0.04	36.0	35.0	0.86	0.65	0.07	0.07	7,344	7,993	175.4	149.1	14.3	15.6
9	Pakistan	51.0	22.0	0.72	0.22	0.06	0.03	27.0	35.0	0.38	0.34	0.03	0.04	5,949	8,612	83.8	84.2	7.5	10.8
10	Philippines	488.0	75.0	11.60	1.31	1.63	0.25	39.0	52.0	0.93	0.91	0.13	0.17	8,163	10,744	194.0	187.3	27.2	35.8
11	Malaysia	17.0	11.0	1.42	0.67	0.05	0.03	9.0	12.0	0.75	0.73	0.03	0.04	2,192	3,114	183.7	188.4	6.6	9.4
12	Bangladesh	7.0	14.0	0.09	0.14	0.05	0.10	29.0	35.0	0.37	0.34	0.20	0.24	5,900	7,076	74.7	69.0	41.0	49.1
13	Viet Nam	4.0	5.0	0.08	0.08	0.01	0.02	25.0	32.0	0.53	0.51	0.08	0.10	4,972	6,612	104.4	105.3	15.0	19.9
14	Hong Kong	4.0	1.0	0.91	0.18	3.83	0.96	1.0	1.0	0.23	0.18	0.96	0.96	378	632	85.9	112.7	361.7	604.8
15	Singapore	0.0	0.0	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.00	0.00	252	300	111.5	114.9	407.8	485.4
16	Nepal	3.0	9.0	0.24	0.51	0.02	0.06	17.0	47.0	1.35	2.64	0.12	0.33	3,302	9,393	262.3	528.0	23.5	66.7
17	Myanmar	3.0	4.0	0.10	0.10	0.00	0.01	17.0	25.0	0.56	0.64	0.03	0.04	3,459	5,049	114.7	129.0	5.1	7.5
18	Sri Lanka	2.0	2.0	0.15	0.12	0.03	0.03	7.0	8.0	0.52	0.49	0.11	0.12	1,590	1,704	117.8	104.2	24.2	26.0
19	Afghanistan	1.7	1.7	0.14	0.11	0.00	0.00	11.9	11.4	1.01	0.75	0.02	0.02	2,450	2,394	208.0	157.3	3.8	3.7
20	Mongolia	0.4	0.4	0.28	0.20	0.00	0.00	2.7	2.8	1.90	1.38	0.00	0.00	565	632	397.9	311.3	0.4	0.4
	Total Asia	3,945.4	6,159.8	1.77	2.24	0.18	0.29	1,511.8	2,055.9	0.68	0.75	0.07	0.10	352,781	496,597	158.6	180.5	16.5	23.3

Source: OECD, 1993, and others

7. Effectiveness of Countermeasures for Environmental Improvement

Anti-air pollution countermeasures are generally classified into three categories those for fuels, combustion, and flue gas. The emission volume of pollutants can be decreased by environmental countermeasures and energy saving. According to Japanese experience, the reduction effect of SOx emission (1974 -1986) is estimated to be about 42 % through energy saving, 35 % through desulfurization, 16 % through changes in the fuel composition, and 7 % through changes in the production composition. Measures against NOx in general consist of fuel modification (mainly for fuel NOx) and combustion modification (mainly for thermal NOx). Reduction to about 50 % can be expected by current combustion modification technologies.

The potential of environmental protection in the energy sector is considered to depend on energy and environmental policies and technologies. The potential in IR Iran will be estimated according to results of further studies in the future.

1) Sulfur Oxides (SOx)

Table II-1.1 and Table II-1.2 show the emission volume of SOx and the reduction ratio achieved by countermeasures against SOx emission in Japan. SOx emission volume in Japan recorded 2,571 thousand tons in 1975. However, the emission volume has decreased rapidly over the years. Actual results in 1987 were 1,143 thousand tons. Supposing that measures for environmental protection had not been taken, the SOx emitted was estimated to be 6,161 and 3,968 thousand tons in 1975 and 1987, respectively.

Actual emission volume accounts for 41.7 % and 28.8 % of the volume which is estimated without countermeasures in 1975 and 1987 respectively. The reduction ratio had increased from 58.3 % in 1975 to 71.2 % in 1987. Itemizing the reduction ratio, the effectiveness of desulfurization of fuels were 32.6 % (1975) and 34.8 % (1987). On the other hand, the effectiveness of Flue Gas Desulfurization (FGD) facilities increased from 25.8 % (1975) to 36.4 % (1987) of the total emission volume estimated. The main countermeasure against SOx emission has been shifting from fuel control to flue gas control.

Table II-1.3 shows the reduction ratio estimated by emission source. As shown in Table II-

1.1, stationary sources account for the major part of total emission volume in Japan (about 91 % in 1975 and 78 % in 1987). The reduction ratio of the FGD system after the desulfurization process of fuels a measure against stationary emission sources has been on the rise. Particularly, the ratio in the power sector has accounted for a high percentage level (66.4 % in 1975, 84.8 % in 1987). Also, in other energy conversion and industrial sectors, the effectiveness of the introduction of the FGD system increased rapidly. The reduction ratio increased from 18 % in 1975 to 48.7 % in 1987.

Table II-1.1 Emission Volume of SOx

(Unit : 1000 t / year)

	Emission Sources	1975	1985	1987
Estimate (no counter-measure scenario)	Stationary	5,798	3,732	3,543
	Power Generation	2,734	2,140	2,093
	Other Industries	2,616	1,232	1,050
	Other Sectors	334	243	243
	Metal Refinery,etc.	114	117	158
	Mobile	363	391	425
	Road	116	213	251
	Others	247	177	174
	Total (A)	6,161	4,122	3,968
Actual	Stationary	2,348	943	889
	Power Generation	631	202	197
	Other Industries	1,416	508	376
	Other Sectors	187	117	118
	Metal Refinery,etc.	114	117	158
	Mobile	223	232	254
	Road	77	141	166
	Others	146	91	87
	Total (B)	2,571	1,175	1,143
Ratio B/A	(B/A) * 100 (%)	41.7	28.5	28.8

Source : "Energy and Global Environmental Problems in Asia", Science and Technology Agency, Japan

Table II-1.2 SOx Reduction Ratio by Countermeasure

(Unit : %)

Reduction Ratio	1975	1985	1987
Fuel Control	32.6	35.2	34.8
Flue Gas De-SOx Control (FGD)	25.8	36.3	36.4
Total	58.3	71.5	71.2

Source : "Energy and Global Environmental Problems in Asia", Science and Technology Agency, Japan

Table II-1.3 SOx Reduction Ratio by Emission Source

(Unit : %)

Countermeasures	Emission Sources	1975	1985	1987
Reduction Ratio by Fuel Control	Stationary	32.3	34.6	34.1
	Power Generation	31.4	37.9	38.1
	Other Industries	34.0	31.0	30.2
	Other Sectors	36.9	39.9	39.6
	Metal Refineries	0.0	0.0	0.0
	Mobile	38.6	40.7	40.2
	Road	33.8	33.9	33.8
	Others	40.8	48.9	49.6
	Total	32.6	35.2	34.8
Reduction Ratio by Flue Gas De-SOx after Fuel Control	Stationary	40.2	61.4	61.9
	Power Generation	66.4	84.8	84.8
	Other Industries	18.0	40.2	48.7
	Other Sectors	11.2	20.1	19.7
	Metal Refineries	0.0	0.0	0.0
	Mobile	0.0	0.0	0.0
	Road	0.0	0.0	0.0
	Others	0.0	0.0	0.0
	Total	38.1	56.0	55.8

Source : "Energy and Global Environmental Problems in Asia", Agency of Science and Technology, Japan

2) Nitrogen Oxides (NOx)

Table II-1.4 and Table II-1.5 show the emission volume of NOx and the reduction ratio through flue gas control. NOx emission volume in Japan was 2,329 thousand tons in 1975 and decreased to 1,935 thousand tons in 1987. Estimates for 1975 and 1987, calculated under the hypothesis that measures against NOx had not been taken are 2,829 and 3,209 thousand tons respectively. Actual emission volume accounts for 82.3 % and 60.3 % of the estimated volume in 1975 and 1987, respectively. The reduction ratio is estimated to be 17.7 % in 1975 and 39.7 % in 1987.

Regarding NOx emission, the volume from mobile sources is lager than that from stationary

sources. The share increased from 55 % in 1975 to 62 % in 1987. The volume emitted on roadways remains at a similar level.

The reduction ratio through flue gas control by emission source increased rapidly for each emission source. In the power sector, the level increased from 55.6 % (1975) to 75.2 % (1987). Secondary, the effectiveness of exhaust gas control on mobile sources (roadways) increased, as shown in Table II-1.6. The reduction rate was estimated to be 39.9 % in 1987.

Table II-1.4 NOx emission volume

(Unit : 1000 t / year)

	Emission Sources	1975	1985	1987
Estimate (no measure-scenario)	Stationary	1,498	1,462	1,423
	Power Generation	713	753	756
	Other Industries	654	566	516
	Other Sectors	131	143	151
	Mobile	1,330	1,664	1,786
	Road	944	1,357	1,474
	Others	386	306	312
	Total (A)	2,829	3,125	3,209
Actual	Stationary	1,056	778	738
	Power Generation	317	187	188
	Other Industries	639	493	446
	Other Sectors	100	98	104
	Mobile	1,274	1,170	1,197
	Road	887	863	885
	Others	386	306	312
	Total (B)	2,329	1,948	1,935
Ratio B/A (B/A) * 100 (%)		82.3	62.3	60.3
Reduction ratio (%)		17.7	37.7	39.7

Source : "Energy and Global Environmental Problems in Asia", Science and Technology Agency, Japan

Table II-1.5 NOx Reduction Ratio by Emission Source

(Unit : %)

Countermeasures	Emission Sources	1975	1985	1987
Reduction Ratio by Flue Gas De-NOx Control	Stationary	29.5	46.8	48.2
	Power Generation	55.6	75.2	75.2
	Other Industries	2.4	13.0	13.7
	Other Sectors	23.4	31.0	30.9
	Mobile	4.3	29.7	33.0
	Road	6.0	36.4	39.9
	Others	0.0	0.0	0.0
	Total	17.7	37.7	39.7

Source : "Energy and Global Environmental Problems in Asia", Science and Technology Agency, Japan

Table II-1.6 shows the effectiveness of automobile exhaust gas control in terms of NOx reduction. The emission volume by LPG cars remains around 2 % of the total volume emitted on road. The share of gasoline cars decreased from 68 % (1975) to 42 % (1987), while, the share of diesel cars increased from 29 % (1975) to 56 % (1987).

Looking at the effectiveness in terms of the reduction ratio, gasoline cars the ratio for increased from 8.2 % (1975) to 54.2 % (1987), and LPG car showed a similar tendency to improve. However, the ratio for diesel car remains at a low level despite the implementation of exhaust gas control. It is supposed that measures against diesel cars are technically complicated and the share of direct jetting- type diesel cars is increasing.

Table II-1.6 Effectiveness of Exhaust Gas Control (NOx) in Automobiles

	Type of Automobile	1975	1985	1987
Estimate (1000 t / year)	LPG Car	32	35	31
	Gasoline Car	657	852	887
	Diesel Car	255	470	556
	Total	944	1,357	1,474
Actual under Control (1000 t / year)	LPG Car	29	17	14
	Gasoline Car	603	395	372
	Diesel Car	255	451	499
	Total	887	863	885
Reduction Ratio (%)	LPG Car	8.4	51.2	54.2
	Gasoline Car	8.2	53.6	58.0
	Diesel Car	0.0	4.0	10.2
	Total	6.0	36.4	39.9

Source : "Energy and Global Environment Problems in Asia", Science and Technology Agency, Japan

8. Environmental Administration in Japan

1. Historical Background (Table 1 and 2)

The environmental administration in Japan has been gradually structured as environmental pollution problems expands in the Japanese archipelago, especially since late 1950's.

In addition to such cases as Minamata Disease and Itai-itai Disease in mid-1950s, caused by environmental contamination by heavy metals, increase of environmental pollution cases was observed in certain areas like Yokkaichi in the late 1950's, though all the development projects of new large scale petrochemical complexes starting from 1955 were carried out in accordance with comprehensive industrial development schemes in those areas.

To cope with such problems various measures were taken, including the enactment of a Factory Effluents Control Law (in 1958) and a Smoke and Soot Regulation Law (in 1962). In late '60s, however, a new tendency was observed that such pollution cases could occur in many regions throughout the nation and that pollution problems were getting more complexed and expanding geographically.

Under such circumstances, a Basic Law for Environmental Pollution Control was enacted in 1967, which provides for the basic principles and framework regarding environmental pollution control measures. The Law stipulates seven typical environmental pollution symptoms namely, air pollution, water pollution, noise, vibration, ground subsidence, and offensive odour, and (from 1970) soil contamination and clearly illustrates the responsibilities of national government, local government, and enterprises.

Environmental legislation made an epochmaking step in 1970, when the Special Session of the national Diet was held to debate environmental pollution control measures. The Diet finally enacted or amended in total 14 laws including the Basic Law for Environmental Pollution Control. In this connection, many regulatory measures against pollution activities were further strengthened and institutional arrangements were drastically expanded.

In 1971, the Diet passed a Law on the Establishment of the Environment Agency, which is to

Table 1 Major Environmental Issues and Environmental Administration

Year	Socio-economic Activities	Major Pollution-related Issues	Measures Taken by Administration
1945	End of the Second World War		
1950	Special procurement demands increased due to the outbreak of the Korean War	Itai-Itai (ouch-ouch) disease became in issue (1955)	
		Outbreak of Minamata disease (1956)	1957 Promulgation of the Natural Parks Law (Abrogation of the National Parks Law)
		Tokyo, Edogawa issue (1958)	1958 Promulgation of the Law relating to the Preservation of Water Quality in Public Waters, and Promulgation of the Law concerning Regulation of Industrial Effluent
1960	Income-doubling program	Air pollution, marine pollution in Yokkaichi-shi (1961)	
1964	Opening of Tokaido Shinkansen line (Tokyo-Osaka) The Tokyo Olympics held		1962 Promulgation of the Law concerning the Emission Control of Smoke and Soot
		Outbreak of Minamata disease in Niigata (1965)	1965 Establishment of the Environmental Pollution Control Service Corporation
			1967 Promulgation of the Basic Law for Environmental Pollution Control
1969	GNP 2nd rank in the free world Opening of the whole line of Tomei and Meishin highways		1968 Promulgation of Air Pollution Control Law and Noise Regulation Law
		Osaka Airport Pollution Suit (1969)	1969 Promulgation of the Law concerning Special Measures for the Relief of the Pollution-related Patients
1970	Osaka International Exposition held	Outbreak of health damage caused by photochemical smog (1970)	1970 Diet session concerning the environmental pollution (Amendment and enactment of 14 laws relating to the environmental pollution)
			1971 Inauguration of the Environment Agency Promulgation of the Offensive Odor Control Law
1972	"Land boom" caused by the Plan for Remodeling the Japanese Archipelago	Red tide issue intensified (1972)	1972 Promulgation of the Nature Conservation Law, Amendments of the Air Pollution Control Law and Water Pollution Control Law (Introduction of the absolute liability system)
1973	The first oil crisis		1973 Promulgation of the Law concerning Special Measures for Conservation of the Environment of the Seto Inland Sea Promulgation of the Pollution-related Health Damage Compensation Law Decision of the Basic Policy on Conservation of the Natural Environment Establishment of the Environmental Quality Standards for Aircraft Noise
		Shinkansen pollution suit (1974)	1974 Partial amendment of the Air Pollution Control Law (Introduction of the areawide total pollutant load control) Institution of the Charter of Nature Conservation
		Hexavalent chromium pollution issue (1975)	1975 Establishment of the Environmental Quality Standards for Shinkansen Superexpress Railway Noise
			1976 Promulgation of the Vibration Regulation Law
			1977 Planning of the long-term program for environmental protection
			1978 Partial amendments of Water Pollution Control Law and the Law concerning Special Measures for Conservation of the Environment of the Seto Inland Sea (Introduction of the areawide total pollutant load control)
1979	The second oil crisis	Decision given by the Supreme Court on the case of Osaka Air-Port Pollution (1981)	
			1984 Promulgation of the Law concerning Special Measures for the Preservation of the Water Quality of Lakes and Ponds Cabinet decision "concerning the implementation of environmental effects assessment".
1979	The second oil crisis	Decision given by the Supreme Court on the case of Osaka Air-Port Pollution (1981)	
			1984 Promulgation of the Law concerning Special Measures for the Preservation of the Water Quality of Lakes and Ponds Cabinet decision "concerning the implementation of environmental impact assessment"
		The final meeting of WCED (Tokyo) (1987) Publication of "Our Common Future" by WCED (1987)	1985 . Promulgation of the Law partially amending the Chemical Substances Control Law . Promulgation of the Law partially amending the Law Relating to the Prevention of Marine Pollution and Maritime Disaster . Release of the Long-Term Plan for Environmental Protection
			1987 . Promulgation of the Law partially amending the Law of the Environmental Service Corporation . Promulgation of the Law partially amending the Pollution-related Health Damage Compensation Law
		Intergovernmental Panel on Climate Change (IPCC) was set up (1988)	1988 Promulgation of the Law for the Protection of the Stratospheric Ozone Layer
			1989 Promulgation of the Law partially amending Air Pollution Control Law Promulgation of the Law partially amending Water Pollution Control Law

coordinate and facilitate relevant environmental protection administration. The Environment Agency was formally established on 1st July, 1971.

2. Functions and Organization of the Environment Agency

2.1 Administrative Responsibilities

The Environment Agency is one of the agencies in the Prime Minister's office, and headed by the Director General who is a Minister of State and member of the Cabinet. It is responsible for:

2.1.1 Planning, drafting and implementation of the basic policies for environmental agencies for environmental protection, coordination of agencies' policy regarding the estimation of expenditures for environmental protection, and unified estimation and allocation of expenditures for research and studies of governmental agencies in the field of environmental protection.

2.1.2 Management and promotion of proper utilization of natural parks, and protection of wildlife.

2.1.3 Formulation of the basic policies regarding Environmental Pollution Control Programs (areawide pollution control programmes under the provisions of the Basic Law for Environmental Pollution Control), establishment of environmental quality standards, implementation of various pollution control laws such as the Air Pollution Control Law, the Water Pollution Control Law and Noise Regulation Law, and implementation of remedial actions for the pollution-related patients.

As a part of the functions of the Director General of the Environment Agency, he is empowered to require necessary explanation and information from the head of the other governmental agencies, and also to make his recommendation to them on important issues. Furthermore he can submit his views to the Prime Minister on such recommendations.

2.2 Administrative Responsibilities of the Bureaux (Fig. 1)

The Bureaux of the Agency have the following functions respectively:

2.2.1 Minister's Secretariat

1) International cooperation under the jurisdiction of the Environment Agency.
2) Investigation of local status concerning the Environment Agency's activities, and collection, arrangement and dissemination of relevant data.
3) General coordination of the activities of the Environment Agency.

2.2.2 Planning and Coordination Bureau

1) Planning, drafting and implementation of basic policies for environmental protection (pollution control).
2) Coordination of functions, budget, and research and studies for environmental protection (pollution control) of the other government agencies.
3) Submission of views on the planning of national land use and development, guiding local government regarding the development of Environmental Pollution Control Programmes.
4) Supervision of the Environmental Pollution Control Service Corporation, a semigovernmental organization to extend loans to smaller industries and to make other arrangements for pollution abatement.
5) Planning, drafting and promotion of basic policies for environmental impact assessment.
6) Management of the National Institute for Environmental Studies and the National Training Institute for Environmental Pollution Control.

The Environmental Health Department of the Planning and Coordination Bureau has the following functions.

7) Operation of the pollution-related health damage compensation system.
8) Scientific studies on causes of pollution-related health damages, investigations regarding chemicals in the environment, remedial measures for pollution-related patients.

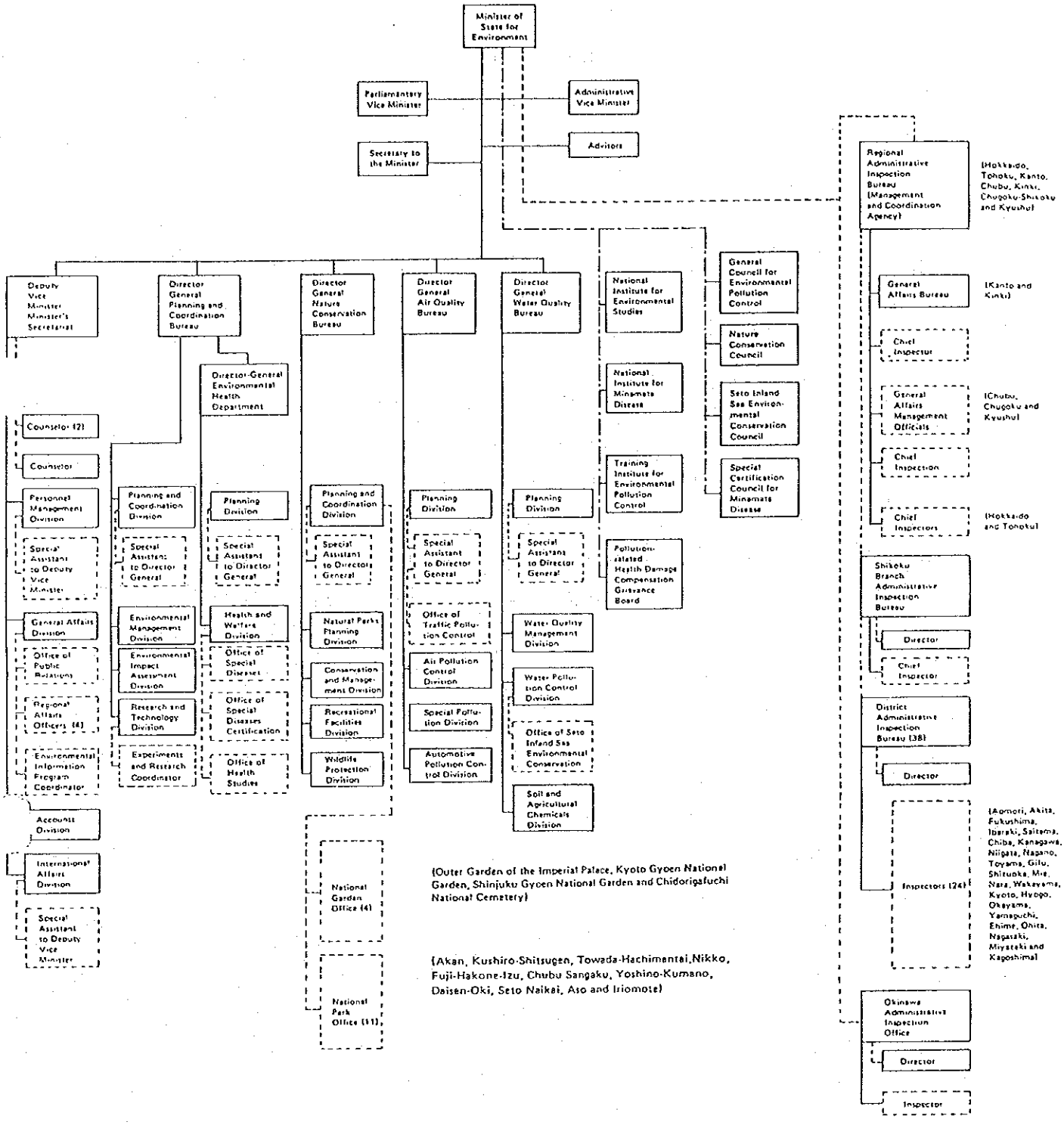


Fig. 1 Oranization of the Environmental Agency

2.2.3 Nature Conservation Bureau

1) Planning and coordination of basic policies for nature conservation and utilization.
2) Designation of natural parks, namely national and quasi-national parks, and other nature protection areas, and guidance for proper utilization.
3) Protection and management of natural parks.
4) Wildlife protection and hunting regulation.
5) Construction and maintenance of recreational facilities.

2.2.4 Air Quality Bureau

1) Establishment of environmental quality standards for air pollution and noise.
2) Regulation of smoke and soot emission and dust control.
3) Regulation of noise and vibration from industries, construction works and motor vehicles.
4) Regulation of emission offensive odor substances.
5) Prevention of environmental pollution resulting from automobile traffic.
6) Coordination of traffic pollution control policies.

2.2.5 Water Quality Bureau

1) Establishment of environmental quality standards for water pollution.
2) Regulation of effluents from industries and others.
3) Establishment of standards for final disposal of wastes.
4) Prevention of agricultural land soil contamination.
5) Regulation of pollution-prone agricultural chemicals.
6) Countermeasures against ground subsidence, including the regulation of the use of underground water.
7) Comprehensive measures for the protection of the environment of the Seto Inland Sea.

Table 2 Major Environmental Legislation in Japan

1. Basic Law for Environmental Pollution Control	(1967)
2. Pollution control laws	
Air Pollution Control Law	(1968)
Water Pollution Control Law	(1970)
Clean Lakes Law	(1984)
Noise Regulation Law	(1968)
Marine Pollution Control Law	(1970)
Soil Pollution Control Law	(1970)
Waste Management Law	(1970)
3. Other related laws	
Sewerage Law	(1958)
Chemicals Control Law	(1973)
Health Damages Compensation Law	(1973)
Pollution-related Crimes Law	(1970)

2.3 Attached Organizations

2.3.1 National Institute for Environmental Studies

1) Research on the effects of environmental pollution on human health and living environment, research of monitoring techniques, et al. Experimental research and surveys concerning pollution prevention.
2) Collection, arrangement and dissemination of data on environmental pollution in the country in the country and abroad.

2.3.2 National Institute for Minamata Disease

Medical investigation and research on Minamata disease.

2.3.3 Training Institute for Environmental Pollution Control

Education and training of officials engaged in environmental administration.

2.3.4 Pollution-related Health Damage Compensation Grievance Board

Dealing with a review from a person who is dissatisfied with the decision regarding certification or ranking in the health damage compensation scheme.

2.3.5 Central Council for Environmental Pollution Control (Appendix 4)

1) Upon request by the Prime Minister, investigation and consideration of fundamental issues relating pollution control measures, and upon request by the Director General of the Environment Agency or the other ministers concerned, investigation and consideration of important issues relating pollution control measures.
2) Offering opinion about the above-mentioned issues to the Prime Minister, the Director General of the Environment Agency, or the other ministers concerned.

2.3.6 Nature Conservation Council

1) Investigation and consideration of the issues under it's authority designated by the Nature Conservation Law, the Natural Park Law, the Law Concerning the Protection and Hunting of Birds and Animals, and the Law Concerning the Regulation on the Transfer of Specific Birds.
2) Upon request by the Director General of the Environment Agency or the other ministers concerned, investigation and consideration of important issues regarding nature conservation, and offering opinions about important issues regarding nature conservation to the Director General of the Environment Agency or the other ministers concerned.

2.3.7 Seto Inland Sea Environmental Conservation Council

Upon request by the Director General of the Environment Agency or the other ministers concerned, investigation and considerations of important issues relating the environmental conservation of the Seto Inland Sea, and offering opinions about important issues relating the environmental conservation of the Seto Inland Sea to the Director General of the Environment Agency or the other ministers concerned.

2.3.8 Special Certification Council for Minamata Disease

Offering opinions when the Director General of the Environment Agency makes decision on certification of Minamata Disease under the Special Law concerning Promotion of Certification of Minamata Disease.

3. Functions of the Other Ministries and Agencies in Relation to Environmental Protection

The main functions conducted by other ministries and agencies in relation to environmental pollution control are as follows:

3.1 Improvement of anti-pollution facilities designated by the Air Pollution Control Law, the Water

Pollution Control Law, and other laws concerning pollution control, and enforcement of other anti-pollution activities.

For instance: improvement of buffering green belts (the Ministry of Construction),
improvement of public sewerage systems (the Ministry of Construction),
dredging rivers, harbors and ports (the Ministry of Construction, the Ministry of Transportation, etc.),
improvement of waste treatment facilities (the Ministry of Health and Welfare),
improvement of ship waste oil treatment facilities (the Ministry of Transportation),
execution of soil pollution control activities, improvement of irrigation drainage facilities for pollution control, capping, etc. (the Ministry of Agriculture, Forestry and Fisheries), and matters relating execution of other activities (including guidance, direction and aid to the related executing bodies)

3.2 Activities Carried Out by Ministries and Agencies as Part of Administrative Guidance

Whereas those activities of factories, which fall under the legally-designated pollution sources such as air pollution or water pollution sources are regulated as the subjects of pollution control under the jurisdiction of the Environment Agency, the administrative guidances for the control of industrial pollution are generally under the jurisdiction of the Ministry of International Trade and Industry. In the same way, depending on the kinds of activities, business activities can be controlled by such responsible ministries and agencies as the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Health and Welfare, the Ministry of Transportation and the Ministry of Construction.

In addition, there are areas where competent ministries have specific roles, such as;

3.3 Guidance and direction by the Minister of International Trade and Industry on electric works, gas works and mining security facilities designated as the special cases in regulation based on the Air Pollution Control Law, etc.

3.4 Regulatory activities over exhaust gas and noise designated by the Road Transportation and Vehicle Law (the Ministry of Transportation)

3.5 Regulations over traffic pollution by the police administration system, and regulation over pollution in the sea by Maritime Safety officials based on the Marine Pollution Control Law.

3.6 Control over damages caused by aircraft noise (air ports are controlled by the Ministry of Transportation, and military bases by the Defense Agency and the Defense Facilities Administration Agency)

3.7 Activities, for instance, for setting up of standards for waste colection and transportation excluding setting up of standards concerning final disposal (regulated by the Environment Agency) (the Ministry of Health and Welfare).

3.8 Activities concerning establishment of standards relating oil discharge from ship, and standards relating methods to discharge wastes generated from daily living on ships or marine facilities (the Ministry of Transportation).

In addition, as to works relating nature protection administration, execution of the Natural Park Law and birds and animals protection administration, which are the core of the administration, are controlled by the Environment Agency, while related administration including forestry administration (reserved forests, et al.), city planning, and protection of cultural properties is taken by ministries and agencies concerned based on laws relating nature conservation. (For example, designation of areas and planning)

Needless to say, the administrative works referred to above are directly or indirectly guided by basic policies or pollution-related laws concerning environmental conservation under the jurisdiction of the Environment Agency.

4. Conceptual Framework of Environmental Protection Measures

Target

(1) Environmental quality standards

(2) Other relevant levels

Actions of the Government

(1) Regulatory measures

1) Permission system for industrial siting and planning

2) Emission regulation by way of emission control standards

3) Regulation on structure, operation or management of industrial facilities

4) Traffic regulations

5) Emergency measures

(2) Industrial siting policy

(3) Social investment

1) Construction of public sewerage system

2) Construction of waste disposal plants

3) Construction of buffer zone green belts

4) Improvement of urban structure

(4) Control measures for environmental pollution caused by the govern metal sector

(5) Monitoring and surveillance

(6) Remedial measures for pollution-related patients

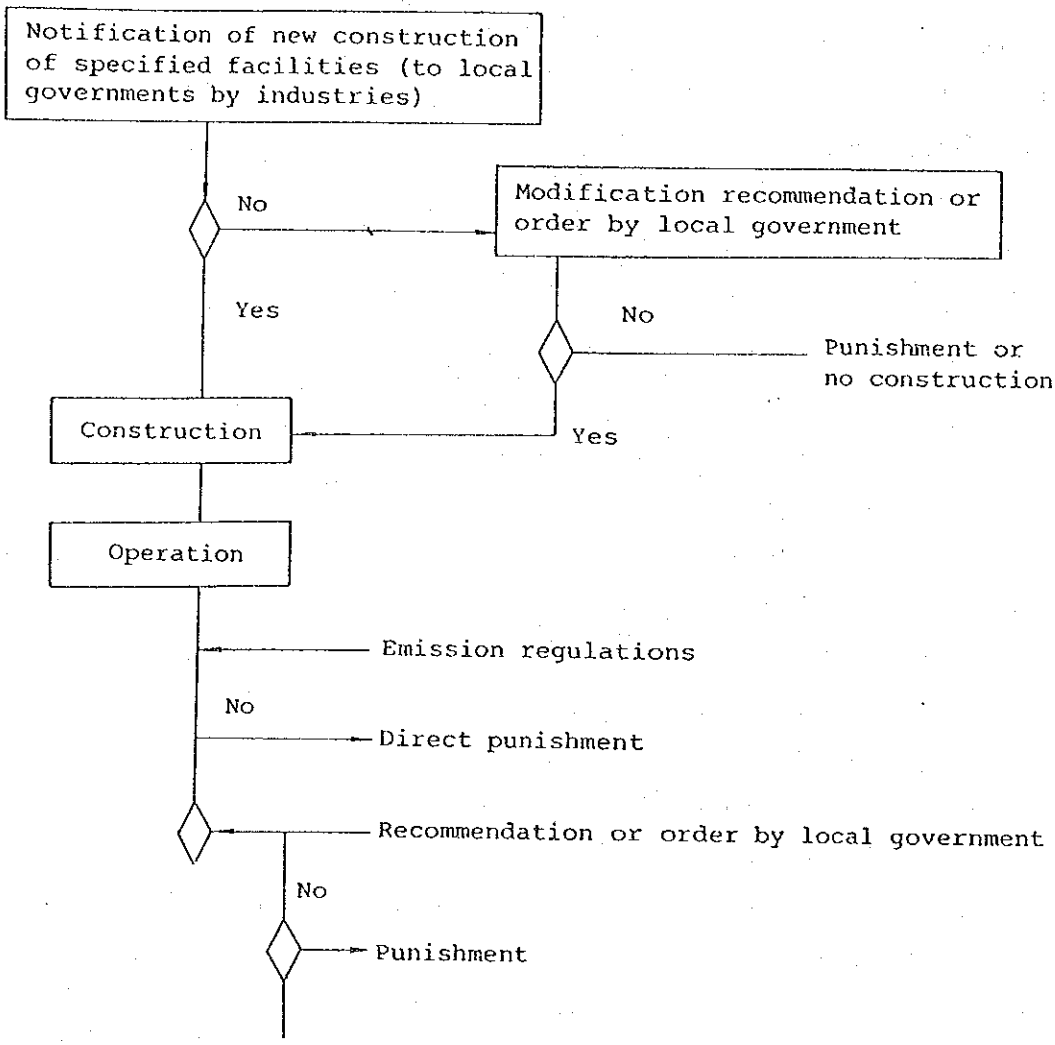
(7) Assistance for the industrial sector

1) Low interest loans for pollution control investment

2) Tax exemption for pollution control facilities, low pollution facilities, etc.

(8) Research and development, information services, etc.

5. Schematic Diagram of Emission Regulation under Air/Water Pollution Control Law



6. Role and Function of the Local Governments

In order to realize an appropriate environmental protection measures paying due consideration to the specific natural and social conditions of the localities concerned, many functions or authorities of environmental protection have been delegated to local government bodies.

For instance many functions provided for by pollution control legislations, such as the Air Pollution Control Law, Water Pollution Control Law and Noise Regulation Law, are delegated to prefectural governors and mayors of specified municipalities.

In principle, all the national pollution regulation standards are national minimum standards and

uniform throughout the nation, but local government bodies are, in most cases, authorized to establish more stringent standards by their ordinance in order to protect their environmental quality. Furthermore, in the cases of certain environmental quality standards, which have different sets of standard levels for different types of areas, prefectural governors are authorized to decide upon assignment of such standard levels to certain areas. (This applies to environmental quality standards for water pollution and noise.)

All the 47 prefectures have already enacted their ordinances for environmental protection, and the number of municipalities, which have pollution control ordinance, has increased from 44 in 1968 to 2,016 as of October, 1985.

Recently it has become a matter of common practice for industries to conclude an agreement with the local government bodies, which very often includes the provisions of more stringent standards than the national ones. The number of factories, which have concluded such agreements, have come to more than 25,000.

7. Financial Aspects of Environmental Pollution Control

7.1 National Government's Expenditure

The national government's budget for environmental pollution control is 1,172 billion yen in FY 1985 as compared to approx. 100 billion yen in FY 1971.

7.2 Pollution Control Expenditure in the Private Sector

Levels of pollution control investment in the private sector (industries) are shown in Figure 2 below. The investment level increased 5.7 times between FY 1970 and FY 1975, namely from 188.3 billion yen to 964.5 billion yen. The investment, however, started decreasing from 1976 onward partly due to economic recession and due to the fact that major pollution control investment had been made in early 1970's especially in cases for air pollution control investment for SOx.

(3) a) Progress of Equipment Investment for Anti-pollution and Its Ratio in Large Enterprises

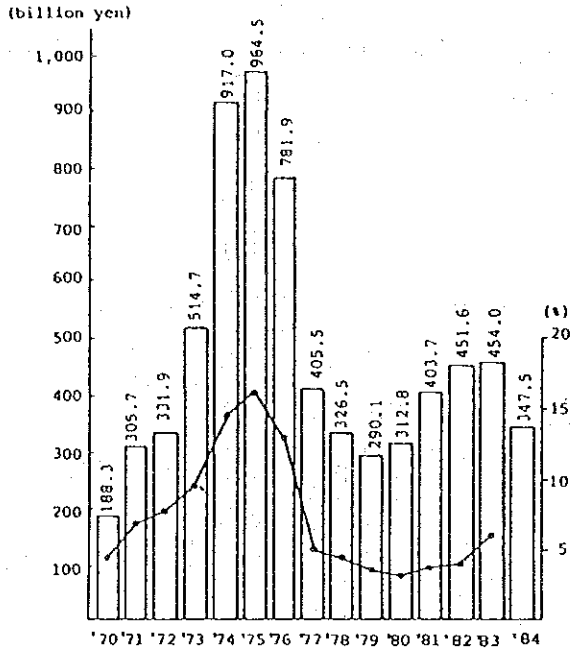


Fig. 2 Trends in Pollution Control Equipment Investments by Private Industry

Note: 1. Based on reports of surveys: "Trend of equipment investment for industrial pollution control in private sector" and "Result and project of equipment investment in major industries" carried out by the Ministry of International Trade and Industry.

2. Subjects of the anti-pollution investment study were enterprises capitalized at more than 50 million for FY 1965 to 1971 and those capitalized at more than 100 million, except for mining industries, from FY 1972 onwards.

3. Numerical values based upon payments.

8. Personnel for Environmental Protection

Although it is very difficult to conclude the number of personnel in various sectors, who are engaged in environmental protection, the number of such personnel who are easily identifiable from the other people is estimated as follows:

a) National government

Environment Agency 917 (as of FY 1988)

b) Local governments

Prefectural governments 7,456 (as of Oct. 1988)

Municipal governments 4,175 (do.)

In addition to the above, in prefectural governments there are 1,524 persons in charge of nature protection.

c) Private Sector

Pollution prevention supervisors 11,700 (as of Mar.1988)
(including Acting supervisors)

Pollution control managers 38,400 (do.)
(including Acting pollution control managers)

9. Complaints, Disputes and Pollution-Related Crimes

(1) The number of complaints against environmental pollution submitted to the local governments and its trends are shown below:

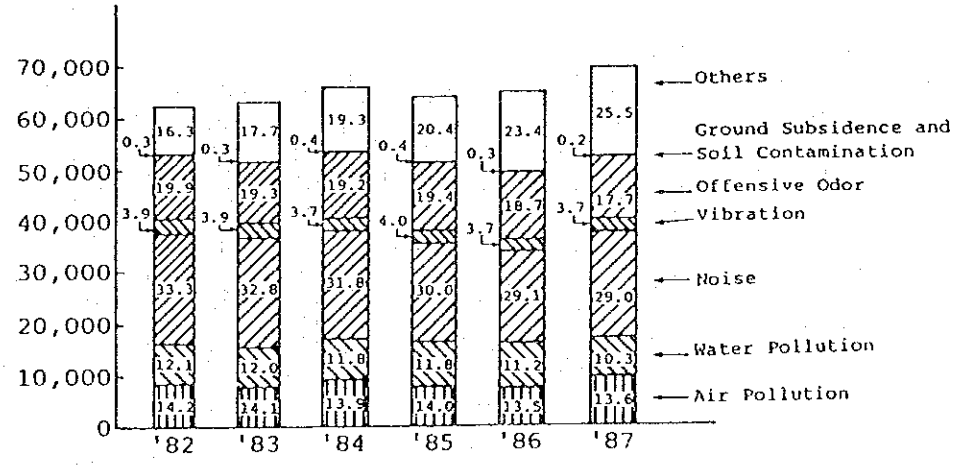


Fig. 3 Changes in the Number of Complaints about Seven Types of Environmental Pollution

(Source) Report by the Environmental Disputes Coordination Commission

(2) The number of arrests for pollution offenses is shown below.

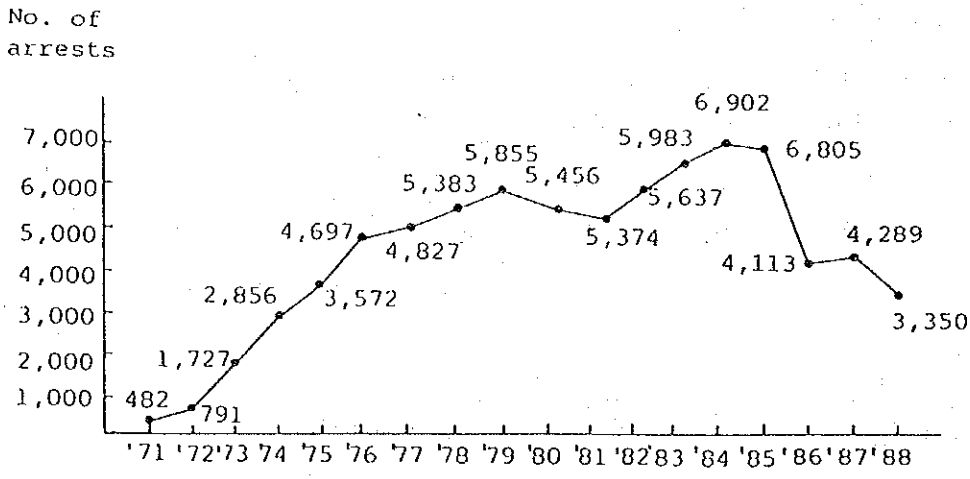


Fig. 4 Arrests for Pollution Offenses

Table 3 Arrests for Pollution Offenses

	1981	1982	1983	1984	1985	1986	1987	1988
Total	5,374	5,637	5,983	6,902	6,805	4,113	4,289	3,350
Water pollution	664	692	668	745	494	210	211	150
Wastes	4,521	4,728	5,228	6,060	6,261	3,886	4,058	3,198
Others	189	217	87	97	50	17	20	2

Note: "Others" includes air pollution, soil pollution, noise and vibration and noxious odor.

(Source) National Police Agency

9. Institutional Mechanisms for Financing Environmental Administration in Japan

1. General Framework of the Government Budget

In fiscal year 1982, national government expenditures from the General Account amounted to 49,680 billion yen. In the same year the total amount of local government expenditures was 47,054 billion yen. The total amount of transfer from the General Account to local governments amounted to 20,138 billion i.e., 40.5 per cent of the General Account to expenditures, 42.8 per cent of local government expenditures came from the General Account of the government, while 36.6 billion yen was transferred to the government. A breakdown of the main sources of local government revenue are as follows:

Local Tax - 32.3 per cent
Local Transfer Tax - 0.9 per cent
Local Equalization Grant - 16.5 per cent
National Expenditure - 21.3 per cent
Local Bonds - 11.3 per cent

The main sources of the government revenue of the General Account are as follows:

Revenue from taxes and revenue stamps - 73.3 per cent
National bond - 24.5 per cent

(Quoted from Ministry of Finance sources for fiscal year 1980)

In addition, the Financial Investment and Loan Scheme of the government is also an important financial source. In fiscal year 1982, the total amount of the Financial and Investment Scheme was 23,788 billion yen. The major sources of this scheme are those accumulated government funds and deposits of pension schemes and postal savings. The main programmes covered by the scheme are housing (25.3 per cent), living environment (14.1 per cent), regional development (1.7 per cent), etc. The budgeting of national and local expenditures and Financial Investment and Loan Schemes provide the basic and common framework for environmental administration. The fiscal calendar in Japan begins in April and ends in March of the following year. In the normal course of events, each

ministerial agency starts budget preparation for the next fiscal year in May and a ministerial budget draft is presented to the Ministry of Finance in September. After scrutinizing and examination hearings of the budget draft by Budgeting Officers of the Ministry of Finance, the first budget draft by the ministry is disclosed in December to each ministerial agency via a Cabinet meeting. In case of legislative action, each ministerial draft law is at first presented to the Cabinet Legislation Agency for examination. If new organization or reorganization of a ministerial agency is planned in the following fiscal year, the organization draft is also presented to the Administrative Management Agency for examination. The draft of budget, legislation and organization also need to be scrutinized by the respective committees concerned of the ruling party, the Liberal Democratic Party (LDP), around November. The financial and taxation policies for the ensuing fiscal year are examined respectively by the Financial Policy Council and the Taxation System Council of the Ministry of Finance. The committees of the ruling party corresponding to those councils also examine the financial and taxation policies in parallel with the Ministry of Finance. As far as the total scale of the following fiscal year's budget as revenue and expenditure are concerned, the Ministry of Finance takes the initiative, but in the case of taxation policies, the Taxation Committee of the LDP plays a decisive role in national and local government taxation policies as a whole. After intensive political interaction and pressure from interest groups, the government's final budget draft is decided through Cabinet resolution, based on the prepared final draft of the Ministry of the Ministry of Finance. The government draft of the next fiscal year's budget presented to the Diet.

The decision for an organization policy is settled, parallel to the final decision making process of the draft budget. In the case of legislative action, the draft law from each ministerial agency cannot be presented at a Cabinet meeting without a final interministerial examination parallel with the examination by the Cabinet Legislative Agency. The policy direction action also has decision making power. Prior to the Cabinet meeting for resolution of the draft law, it is required to be scrutinized by the LDP. A cabinet resolution for the draft law is made just after approval of the LDP for the draft law. The legislative deliberation schedule of the Diet is decided through complex political interactions among all parties. After the completion of the necessary parliamentary procedure of both House of the Diet, the draft budget and the draft law are approved and become the new fiscal year budget and the new law to be promulgated. Those are not only purely administrative procedures, but also complex processes of political and social interaction. Local governments also follow more or less the same process, although after some months delay. After the settlement of national government budget as well as the official issue of guidelines of national policies and subsidy programmes etc., local

governments must revise their initial budget plans to match the forthcoming national subsidy programmes concerned. As far as international cooperation and assistance programmes are concerned, the Ministry of Foreign Affairs is responsible for preparing the budget plans of the Japan International Cooperation Agency and the Japan Foundation, and is also responsible for budget preparation of the Japanese government's contributions to the international organizations concerned. The institutional mechanisms of budgeting are the most basic, substantive procedures for coordination and overall integration

2. The Scale of the Environmental Conservation Budget

In fiscal 1982, the environmental conservation budget amounted to 1,192 billion yen. The total budget for public works, which is assumed as the expenditure which has a variety of environmental impact portential, amounted to 6,654 billion yen. The total national budget amounted to 49,681 billion yen. That is to say 2.4 per cent of the national budget was spent for environmental conservation purposes which corresponded to 17.9 per cent of the total public works budget. In the case of the Financial Investment and Loan Scheme, 1,300 billion yen was allocated to the budget of environmental conservation from a total of 20,288 billion yen. Out of 20,288 billion yen, 19,176 billion yen was allocated for domestics investment and loans. Thus, 6.4 per cent of the Financial Investment and Loan Scheme was allocated to environmental conservation, which is 6.8 per cent of domestic investment and loans. The environmental conservation budget has been increased twenty-five times from the 1967 fiscal year to 1983. The total amount of pollution control investment by manufacturing enterprises during this year was nearly 600 billion of 11,820 billion yen from a total investment. That is about 5.1 per cent of total investment. In fiscal 1982, 165 billion yen of the Financial and Investment Scheme was allocated for the purpose of pollution control investment loans for private enterprises. It can be assumed that about one-fourth of private investment for pollution control was aided by this government loans scheme. Based on the OECD report of Environmental Policies in Japan, subsidy-equivalents of assistance scheme as a percentage of private anti-pollution investment in Japan was 2.6 per cent in 1975, which represented the second lowest rate among the six OECD member countries. The Environment Agency is responsible for coordinating budgeting related to environmental conservation. Based on the Annual Report of Environmental Quality, 1983, fifteen ministerial agencies had budget items for environmental pollution control and eight had items of nature conservation in 1982. The environmental pollution control budget amounts to 1,192 billion yen, and the nature conservation budget amounts to 108 billion.

The classification of the environmental conservation budget in fiscal 1982 is as follows:

-Various programmes of standards setting	1 billion yen
-Enforcement programmes	5 billion yen
-Environmental pollution abatement programme assistance	9 billion yen
-Promotion of public works related to environmental pollution control	1,008 billion yen
-Promotion of studies, research and development	5 billion yen
-Compensation, and relief for pollution-related victims	19 billion yen
-Promotion of nature conservation	108 billion yen
-Others	7 billion yen
-Total	1,192 billion yen

Those public works related to environmental pollution control measures, such as sewerage development (696 billion yen) and noise abatement in areas surrounding airports or air defense force bases, are the two biggest programmes among 1,008 billion yen programmes. The budget of the Environment Agency in 1982 was 46 billion yen.

The government finances have been under severe restraint due to the heavy burden of national bonds -- 122,000 billion yen in fiscal 1984. The public works budget has decreased by 2 per cent, and the Environment Agency budget has decrease by 2.6 per cent between fiscal 1983 and the fiscal 1984 budget. The government financial recovery plan by 1990 has been submitted to the Diet and administrative reform has proceeded. In spite of these financial difficulties, the budget allocated for international cooperation and assistance programmes has been increased by 9.7 per cent. This represents the highest rate of increase indicating exceptionally favourable budgetary treatment.

3. Special Financial Measures for Environmental (Conservation) Administration

3.1 Special Financial Measures for the Costs of Areal Environmental Pollution Control Planning

Areal pollution control planning is provided by Article 19 of the Basic Law for Environmental Pollution Control Measures (1967 and 1970). This is a comprehensive long- or medium-term plan covering both public and private sectors. The subsidy rates for those programmes of local government, such as development of a monitoring station network, laboratory equipment, and public works facilities related to environmental pollution abatement are higher than the normal rate. For

example, subsidies range from as much as one-half to two-third higher than the normal rate. The special subsidies for the payment of interest on local bonds can also be provided. The Law of Special National Financial Measures for Environmental Pollution Control Programmes was enacted in 1971. A little more than 20 billion yen as incremental increase was allocated each fiscal year for special higher rates of national shares and subsidies.

3.2 The Law of Cost Bearing of the Enterprise for the Expenditure of Pollution-Related Public Works

This law was enacted in 1970, in accordance with article 22 of the Basic Law for Environmental Pollution Control Measures of 1967. The kinds of pollution-related public works are provided by Article 2 and further substantiated by Cabinet Order. These are as follows:

1) Green belt to be utilized as a buffer zone.
2) Dredging of bottom sediments of accumulated pollutants and construction of irrigation facilities in public water zones as responses to industrial pollution.
3) Land reclamation and necessary facilities for reduction of agricultural soil pollution.
4) Sewerage and waste treatment facilities mainly used by industries.
5) Relocation of residential housing areas adjacent to industrial pollution.
6) Joint industrial building for the purpose of joint pollution control.

Industry's share in costs will be settled by the Cost Bearing Council. Proportion of rates extending to 100 per cent of necessary costs, based on the extent of pollution contribution of the enterprise concern, will be decided by the council. Sixty-two projects from the 136 billion programme expenditures had been executed by the end of fiscal year 1982. The total share of costs to be borne by enterprises amounted to 68 billion yen, i.e., a 50 per cent share.

3.3 The Environmental Pollution Abatement Corporation Law, 1965

This is a quasi-governmental corporation organized under the 1965 law. The corporation has two functions; the first is direct construction based on the contract between the enterprise and the corporation, and the easy payment system of long-term and low interest rates, and the second is the loan scheme. The construction programmes are as follows:

1) Joint pollution abatement facilities of plural enterprises.
2) Joint industrial building with joint pollution abatement facilities and equipment.
3) Industrial estates for relocation of the polluting industry.
4) A green belt buffer zone facility.

In the 1982 fiscal year, 78 billion yen worth of projects were contracted and 64 billion yen were executed; construction projects amounted to 25.7 billion yen and the loan scheme amounted to 38.3 billion yen; the Financial Investment and Loan Scheme provided 40.1 billion yen and the corporation controlled 23.9 billion yen as its own capital fund.

3.4 Special Financial Measures for Lake Environment Conservation

The Law of Special Measures for Comprehensive Development of Biwako (Lake Biwa) of 1972 provided special higher rates of various national subsidies in relation to the water conservation programmes by Article 2-2 and Article 8. The Law of the Special Measures for Water Source Areas (1973) also provided similar higher subsidy rates in relation to the water conservation programmes in designated lakes. The pollution control programmes in Kasumigaura (Lake) basin are supported by this law. The area around the two lakes is not designated as areal environmental pollution control planning provided by Article 19 of the Basic Law for Environmental Pollution Control Measures 1967, 1970.

3.5 Tax Incentives

The 1957 Law of Special Measures for Taxation provides time-limited tax favours of the special depreciation of the designated pollution control facilities and equipment, especially those of small- and middle-scale enterprises. The cost of preparation of funds for mining hazards prevention is discounted as a loss. The special discount of income tax on land transfers in the industrial plant relocation project by small- and middle-scale enterprises is also provided by the law. The law also provides tax favours for income attributed to the transfer of property by those legal provisions related to the ancient capital environmental protection programme, aviation noise defense works in areas surrounding airports and defense air force bases, and also of cultural property protection and nature conservation, national parks and security forests. The Registry Tax in case of property acquisition for

plant relocation projects by small- and middle-scale enterprises is also discounted by the law. All these tax favour measures are time-limited as provided under the laws of income taxes and legal person taxes. The Local Tax Law also provides special tax favours of business taxes of the quasi-governmental corporation, and the fixed assets tax favours properties gained through the projects of the Environmental Pollution Control Abatement Corporation. Those tax favours are time-limited measures provided by prefectural tax. The Local Tax Law also provides tax favours for fixed assets tax exemption for designated cases in specially designated protection areas of the National Park Law. The Local Tax Law also provides tax exemption of special land ownership tax in case of the land space exclusively for pollution abatement facilities. Those tax favours are provided as time-limited measures by municipal tax. In the case of encouragement for earlier sales of less-polluting cars, the stringent auto exhaust standards were satisfied earlier than the designated time for enforcement, and special tax discount measures were provided by the Local Tax Law in automobile acquisition taxes by a prefecture by the fiscal year 1977. However, many of these tax favours will be abolished under the tax policy revision which embodies stringent financial recovery programmes for the 1984 fiscal year. The expansion of desulfurization programmes through the import of low-sulfur crude oil, development of desulfurization facilities in refineries and stack gas were accelerated through tax favour measures by the 1978 fiscal year. The change in enforcement schedules for automobile exhaust gas emission standards from 1975 to 1978 was also influenced by those tax favour taken in fiscal year 1977.

3.6 Resource Finance Tax Measures

The cost for road construction and also traffic noise abatement are financed by the revenue from gasoline taxes. Aviation noise alleviation work in the surrounding areas of airports is financed by the revenue from the aviation fuel tax. Two-thirteenths of the revenue from the aviation fuel tax is also allocated to the municipal governments concerned by the Aviation Fuel Tax Transfer Law.

3.7 Financial Measures for Compensation

Compensation for property right and loss of income to fishermen and rural residents in cases of land reclamation of public water zones, and relocation for dam construction have been practiced for a long time. However, compensation for damages caused by environmental pollution are rather recent issues, having only taken place during the past decade. The basic and essential difficulties are deeply

rooted in the legal of cause-effect relationships and of civil liability. The conclusion of the investigation into Itai-itai disease by the Ministry of Health and Welfare in 1968 facilitated legislation of the Special Law of Relief of Pollution Related Diseases Patients (1969). A series of court verdicts in relation to pollution-related disease damage after 1971 accelerated the legislation of strict liability as the provisions of the Air Pollution Control Law and also the Water Pollution Control Law in 1972. The court verdict concerning the case of the Yokkaichi air pollution dispute provided a legal evaluation scheme for loss of earnings of patients. The pollution related Health Damage Compensation Law of 1973 was enacted, based on the strict liability legislation of 1972 and the precendent of the Yokkaichi court verdicts in relation to legal judgement of the cause-effect relationship between pollution and diseases, as well as the evaluation of loss of earnings. The pollution burden levy system provided by Articles 52, 53, and 54 of the law is a type of resource finance charge system. The law provides two categories of diseases eligible for compensation benefits. Those are, firstly, nonspecific pulmonary diseases in relation to health damage caused by air pollution, and secondly, specific diseases relating to health damage caused by toxic pollution of air and/or water. The designation of compensation areas is based on the criteria of pollution grades in the past and the grade of prevalence of chronic bronchitis symptoms in the event of air pollution. In the case of specific diseases, the affected area by specified pollution incident designated based on the results of extensive investigation of pollution and health effects. The prefectural government, within the jurisdiction of designated areas, is legally requested to establish a presidential committee for certification of patients in relation to designated diseases, followed by an evaluation of the disability of the patients. Compensation takes the form of medical care costs and disability benefits according to the severity of disease. The fee scale for medical care and the disability payment scale are provided under the law. The total costs for payment of those benefits is calculated in advance for the next fiscal year. As far as specific diseases are concerned, the responsible industry must bear all the costs of these benefits. The pollution burden levy is the instrument for financing 80 per cent of the costs of all benefits in relation to patients with nonspecific diseases, certified in designated areas. The pollution burden levy is graded into four classes in accordance with designated areas. The pollution burden levy is also applied outside of designated areas on a nationwide basis with a flat rate. The maximum levy rate is 2,559.19 yen per cm^3 of SO_2 emission, and the lowest levy rate in designated areas is 942.86 yen per cm^3 of SO_2 emission. The levy rate outside of the designated area is 149.66 yen per cm^3 of SO_2 emission. Those SO emissions are the total amount of emission per year, which is estimated and notified by those owners of emission sources to the Association of Pollution Related Health Damage Compensation through the network of the local Chambers of Commerce. Twenty per

cent of the costs of all benefit is shared by the Association of Pollution Related Health Damage Compensation. The national government provides a grant to the association out of revenue from the Automobile Weight Tax. This is based on the calculation of pollutants emission from stationary sources and mobile sources on a nationwide basis. So far as the calculation of pollutants emission is concerned, both SOx and NOx are calculated by using an emission inventory. However, the levy system for stationary sources is based on the amount of emission of SOx notified by the owners of stationary sources. The total number of certified patients of specific diseases (Minamata disease, Itai-itai disease and chronic arsenic poisoning) amounted to 2,067. The estimated cost of compensation benefits for certified patients related to air pollution was 89 billion yen in fiscal year 1983. The 1950 Mining Enterprise Law includes the provision of nonfault liability in Article 109. Article 117 provides the clause for the security deposit as insurance against the risk of compensation payment. In the case of coalmines 20 yen per ton is requested as a deposit, and for other ores, 1 per cent of the price of extracted ores. In the case of the nonexistence or unavailability of a liable miner, victims of mining hazards can claim the compensation payment from the deposit of security at the Regional Bureau of MITI. The 1975 Oil Pollution Damage Security Law provides liability of oil pollution damage compensation under Article 3. Japanese oil tankers exceeding 2,000 tons are legally forced to contract for security against compensation payment. The undertaker of specified petroleum by Article 28 must contribute to the International Fund as specified by Article 10 of the 1969 Treaty of the International Fund. This is a kind of international institutional mechanism for compensation for oil pollution damage. The Law of Land Reclamation in Public Water Zones, 1921 includes Article 6 for compensation for loss of fishery rights in water zones by the licensed person of land reclamation by Article 2.

The 1951 Land Expropriation Law provides liability for compensation (Article 69), payment (Article 70) and the amount of compensation (Article 71), etc. Compensation under these two laws has been practiced for many years. Property rights are protected by Articles 29 and 31 of the Japanese Constitution. Legal provision in respect of private property rights and to coordinate with the public interest can be found in Article 3 of the 1957 National Park Law, Nature Conservation Law of 1972, and also Article 70-2 of the Cultural Property Protection Law. Compensation for loss caused by specified legal actions is also requested under Article 33 of the Nature Conservation Law and Article 35 of the National Park Law. Legal Compensation for loss by the Cultural Property Right Protection Law is limited in cases of damage caused on the occasion of requested exhibitions and disclosure to the general public. The 1975 Law of Special Measures for Preservation of Historical Environs and

Development of Living Environments in Asuka Village represents a milestone development. The law established the Asuka Village Development Fund under Article 8 which provides the financial resources for the necessary programmes. The national government provides 2.4 billion yen under the same article. Special city planning is requested under Article 3 to include preservation of historical environs and the formulation of the basic development policy is requested under Article 4. Special higher rates of subsidies for basic infrastructure development programmes are provided under Article 5.

In 1976, the Environment Agency started a subsidy programme for the purchase of private land endowed with natural scenery of high value by prefectural grant-bonds. The subsidy rates are from 1/10 to 5/10, mostly over 8/10. The eligible land is to be in the special designated district of national parks or nationally designated parks or special protection districts for birds and animals. The total amounted to 1,949.22 ha costing 3.9 billion yen by the end of fiscal year 1982.

3.8 The Forest Conservation Fund

The Japanese forest industry is now in a distressing situation due to the decline of lumber demand and prices due to the impact of cheaper imported lumber. The National Forestry Agency had a financial burden of accumulated deficit amounting to 446.9 billion yen on its special account in fiscal year 1982. Because of excess logging in the past, the low level of logging will continue more than 10 years into the future. As a consequence, forestry management has been hard hit. This is also unfavourable for the water conservation capacity of mountain regions, which are important water source areas for urban, industrial, and agricultural regions downstream. Meanwhile, the global problem of deforestation of tropical forests has become a subject of growing national concern. Since Japan is the leading nation in the import of lumber from tropical countries, the improvement of domestic forest management and cooperation and assistance for forestry development abroad have become important directions for environmental policy. The National Forest Agency has been trying to encourage public participation for forest management through public sharing system for the harvest of forest products through the payment of membership fees. Some local governments have also been trying to establish forest funds and appealed to the public for contributions for future forest development. Special merits for those sharing the fund have been recently advocated. A private owner of forest donates her forest property and private money for establishment of a legal person for nature conservation. The legal person in such case is classified as an organization for public interest.

The Environment Agency issued the report of the working committee for "National Trust" development in Japan. In this paper, the Environment Agency recommended the initiation of organizational efforts at the local level as being desirable at the present stage. Some financial support from local governments is to be expected. The needs of national efforts for the provision of the special measures for favourable tax treatment are also very much emphasized. The Environment Agency appealed to call the organization the "People's Environmental Fund." Those types of public participation and public sharing for forest development and green conservation are gradually growing. The same type of approach has been also growing for the preservation of the environs of architectural compounds with important cultural value in several local communities.

The Japan International Cooperation Agency has been operating technical cooperation and assistance in several countries for forestry development based on bilateral agreement with the host countries concerned. The Green Defense Fund was also established to promote a national campaign for green development and conservation both domestic and abroad. Two big newspaper companies, Asahi and Yomiuri, have advocating a green conservation campaign; Asahi supports forest problems while Yomiuri supports the problem of urban greenery. Green development in urban areas is also promoted by programmes of the Ministry of Construction. The programmes of urban parks, roadside green belts and green buffer zone development in surrounding areas of industrial complexes as public parks have been popular for decades. The Environmental Pollution Abatement Corporation has the programme of green belt buffer zone development as a city planning facility with a cost sharing rule between municipal government and industrial enterprise. The Law of Cost Bearing by Enterprises for Public Works for Environmental Pollution provides the rule of cost sharing in the project. The 1974 Industrial Siting Law provides the requirements of green space for new industrial plant development. Based on the requirements of Article 4-1, open greenery should constitute more than 20 per cent of the total plant siting area in any new industrial plant.

4. Basic Common Principles in Financing Environmental Administration

The most traditional well-established principles are firstly "the causative agent should pay for the damage or loss for which he is responsible," and secondly "the beneficiary should pay for the benefit he received." The third principle is in relation to the problem of social cost sharing. The problems of environmental degradation, pollution, and destruction have been external side effects of economic activities both private and public. That is called external diseconomy. How to internalize

those externalities is the crucial issue for environmental administration. Legal enforcement is the direct approach, and economic instrumentation is the indirect approach. In the case of an absence of both approaches, the social and public pressure approaches, such as mass movements of the fishermen's union, farmers' union and victims groups, have taken place in the past. In the history of Japanese environmental policy development, anti-pollution action forced the internalization of the external side effects of industrial and governmental activities. The court verdict of compensation payment is a kind of integrated approach between social persuasion and legal instrumentation. However, it is important that the court's legal action is always the retrospective approach. In the case of the Minamata incident in Kumamoto Prefecture, the Chisso Company has already paid more than 60 billion yen in compensation to victims and payment is expected to increase well into the future. If Chisso had spent 30 yen or 50 million yen in the first place for an industrial effluent treatment plant before 1955, it could have saved compensation amounting to more than 60 billion yen. The Law of Cost Bearing by Enterprises for Public Environmental Pollution Abatement Work is based on the principle of sharing the social cost. The Pollution Burden Levy System for enterprises outside the designated area for compensation is also based on the principle of sharing the social cost in undetermined cause-effect relations and also economic interdependence of industries in Japanese territory. The fourth principle, which was advocated and recommended by OECD, is the "Polluters-Pay-Principle." This is a kind of economic principle embodied in a political slogan. When environmental pollution is caused by production and consumption, pollution control costs should be integrated into the cost of production and consumption; this is the idea expressed in the OECD principle. This is not a legal principle, nor a moral or ethical principle. However, Japanese policy implementation for financing environmental costs in relation to internalization of the external diseconomy has legal implication with some moral tone.