TABLES

Table 16.3.1 Increase of Pollutants from 1996 to 2010 by Sub-catchment Area

Share of BOD Increase by sub-catchment Area

No.	Sub-catchment Area	Dom.	Ind.	Live.	Non S.	Total	Rank
4	Troi River	9.6%	29.9%	0.3%	0.6%	40.4%	1
7	Hong Gai North Basin	17.6%	0.0%	0.2%	0.3%	18.1%	2
8	Hong Gai South Basin	9.2%	0.0%	0.1%	0.1%	9.4%	3
10	Cam Pha West Basin	4.8%	1.3%	0.1%	0.1%	6.2%	4
3	Bai Chay Basin	5.1%	0.0%	0.1%	0.1%	5.3%	5
6	Dien Vong River	3.4%	0.0%	0.4%	0.0%	3.9%	6
9	Ha Tu Basin	2.9%	0.2%	0.4%	0.2%	3.7%	7
13	Cua Ong Basin	0.3%	2.6%	0.0%	0.0%	2.9%	8
11	Cam Pha Central Basin	1.0%	1.3%	0.1%	0.1%	2.5%	9
5	Man River	0.2%	1.4%	0.2%	0.4%	2.2%	10
2	Hung Thang Basin	1.7%	0.0%	0.1%	0.3%	2.1%	11
12	Cam Pha East Basin	0.3%	1.2%	0.0%	0.1%	1.7%	12
1	Mip River	0.7%	0.0%	0.4%	0.0%	1.1%	13
14	Mong Duong River	0.4%	0.2%	0.1%	0.0%	0.7%	14
15	Cat Ba Island	0.0%	0.0%	0.0%	0.0%	0.0%	15
	Total	57.2%	38.0%	2.6%	2.2%	100.0%	

Share of COD Increase by sub-catchment Area

No.	Sub-catchment Area	Dom.	Ind.	Live.	Non S.	Total	Rank
4	Troi River	9.0%	24.2%	0.2%	1.8%	35.2%	1
7	Hong Gai North Basin	16.4%	0.1%	0.2%	0.7%	17.3%	2
8	Hong Gai South Basin	8.5%	0.0%	0.1%	0.2%	8.9%	3
10	Cam Pha West Basin	4.4%	1.3%	0.1%	0.2%	5.9%	4
6	Dien Vong River	4.6%	0.1%	0.3%	0.1%	5.1%	5
3	Bai Chay Basin	4.8%	0.0%	0.1%	0.1%	5.0%	6
12	Cam Pha East Basin	0.3%	4.4%	0.1%	0.2%	5.0%	7
9	Ha Tu Basin	2.7%	0.7%	0.3%	0.3%	4.0%	8
5	Man River	0.3%	1.4%	0.1%	1.4%	3.3%	9
13	Cua Ong Basin	0.3%	2.5%	0.0%	0.0%	2.8%	10
11	Cam Pha Central Basin	1.0%	1.4%	0.1%	0.2%	2.6%	11
2	Hung Thang Basin	1.6%	0.0%	0.2%	0.6%	2.3%	12
14	Mong Duong River	0.4%	0.8%	0.1%	0.1%	1.4%	13
1	Mip River	1.0%	0.0%	0.3%	0.0%	1.3%	14
15	Cat Ba Island	0.0%	0.0%	0.0%	0.0%	0.0%	15
	Total	55.1%	36.9%	2.1%	5.9%	100.0%	

Share of SS Increase by sub-catchment Area

No.	Sub-catchment Area	Dom.	Ind.	Live.	Non S.	Total	Rank
4	Troi River	4.2%	11.8%	0.3%	1.1%	15.2%	1
9	Ha Tu Basin	1.3%	4.7%	0.5%	7.6%	14.1%	2
14	Mong Duong River	0.2%	2.0%	0.1%	9.0%	11.3%	3
10	Cam Pha West Basin	2.0%	0.6%	0.1%	7.9%	10.6%	4
6	Dien Vong River	2.1%	0.2%	0.4%	7.6%	10.3%	5
5	Man River	0.1%	0.6%	0.2%	7.0%	8.0%	6
12	Cam Pha East Basin	0.1%	4.8%	0.1%	2.5%	7.6%	7
7	Hong Gai North Basin	7.8%	0.1%	0.3%	0.9%	7.3%	8
8	Hong Gai South Basin	4.1%	0.0%	0.2%	0.0%	4.2%	9
11	Cam Pha Central Basin	0.4%	0.8%	0.1%	2.4%	3.7%	10
13	Cua Ong Basin	0.1%	1.1%	0.0%	1.5%	2.8%	11
3	Bai Chay Basin	2.3%	0.0%	0.1%	0.0%	2.4%	12
1	Mip River	0.5%	0.0%	0.7%	0.2%	1.3%	13
2	Hung Thang Basin	0.8%	0.0%	0.2%	0.1%	1.1%	14
15	Cat Ba Island	0.0%	0.0%	0.0%	0.0%	0.0%	15
	Total	25.9%	26.9%	3.4%	43.8%	100.0%	

Share of T-N Increase by Sub-catchment Area

No.	Sub-catchment Area	Dom.	Ind.	Live.	Non S.	Total	Rank
4	Troi River	8.8%	21.6%	0.4%	2.1%	33.0%	1
7	Hong Gai North Basin	15.7%	0.0%	0.2%	0.6%	17.5%	2
8	Hong Gai South Basin	8.7%	0.0%	0.0%	0.2%	8.9%	3
6	Dien Vong River	5.5%	0.0%	0.5%	0.9%	6.9%	4
10	Cam Pha West Basin	4.0%	0.7%	0.0%	0.7%	5.4%	5
3	Bai Chay Basin	5.0%	0.0%	0.2%	0.1%	5.3%	6
9	Ha Tu Basin	2.9%	0.4%	0.3%	0.9%	4.6%	7
13	Cua Ong Basin	0.2%	3.4%	0.0%	0.1%	3.7%	8
12	Cam Pha East Basin	0.2%	3.0%	0.0%	0.4%	3.6%	9
5	Man River	0.3%	0.7%	0.1%	2.3%	3.5%	10
2	Hung Thang Basin	1.5%	0.0%	0.2%	0.6%	2.3%	11
14	Mong Duong River	0.2%	0.3%	0.2%	1.4%	2.1%	12
11	Cam Pha Central Basin	0.8%	0.7%	0.0%	0.3%	1.7%	13
1	Mip River	1.0%	0.0%	0.4%	0.0%	1.4%	14
15	Cat Ba Island	0.0%	0.0%	0.0%	0.0%	0.0%	15
	Total	55.9%	30.9%	2.5%	10.7%	100.0%	

Share of T-P Increase by Sub-catchment Area

No.	Sub-catchment Area	Dom.	Ind.	Live.	Non S.	Total	Rank
4	Troi River	5.8%	16.6%	1.8%	10.5%	34.8%	1
7	Hong Gai North Basin	11.5%	0.1%	0.0%	2.9%	14.5%	2
5	Man River	0.0%	0.3%	0.9%	7.5%	8.8%	3
6	Dien Vong River	4.2%	0.1%	2.8%	0.8%	7.9%	4
8	Hong Gai South Basin	5.6%	0.0%	0.0%	1.2%	6.9%	5
9	Ha Tu Basin	2.3%	0.2%	1.0%	2.0%	5.5%	6
3	Bai Chay Basin	2.8%	0.0%	1.0%	0.7%	4.5%	7
2	Hung Thang Basin	1.2%	0.0%	0.0%	2.5%	3.7%	8
10	Cam Pha West Basin	2.3%	0.2%	0.0%	0.7%	3.2%	9
1	Mip River	0.0%	0.0%	2.8%	0.0%	2.8%	10
12	Cam Pha East Basin	0.0%	0.3%	1.0%	1.0%	2.4%	11
13	Cua Ong Basin	0.0%	2.0%	0.0%	0.1%	2.1%	12
14	Mong Duong River	0.0%	0.1%	1.0%	0.8%	2.0%	13
11	Cam Pha Central Basin	0.0%	0.2%	0.0%	0.7%	0.9%	14
15	Cat Ba Island	0.0%	0.0%	0.0%	0.0%	0.0%	15
	Total	35.8%	20.3%	12.5%	31.4%	100.0%	

Source : JICA Study Team

Table 16.3.2 Share of Pollutant Increases by Pollution Source and Sub-catchment Area

No.	Sub-catchment Area	BOD (kg/day)					COD Mn (kg/day)				
		Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total
1	Mip River	41	0	23	0	67	95	2	30	0	127
2	Hung Thang Basin	104	0	8	15	127	154	0	45	55	224
3	Bai Chay Basin	306	1	6	4	317	466	3	10	13	492
4	Troi River	574	1,795	17	37	2,423	875	2,363	22	178	3,438
5	Man River	14	82	10	25	131	30	140	14	137	321
6	Dien Vong River	206	1	22	2	231	445	7	28	14	494
7	Hong Gai North Basin	1,051	1	12	19	1,086	1,603	5	20	66	1,694
8	Hong Gai South Basin	550	0	6	7	563	833	1	10	22	866
9	Ha Tu Basin	174	14	26	10	224	259	69	28	32	388
10	Cam Pha West Basin	236	75	8	4	323	427	125	5	15	572
11	Cam Pha Central Basin	62	77	4	4	147	98	136	5	15	254
12	Cam Pha East Basin	20	71	2	6	99	25	433	5	22	488
13	Cua Ong Basin	16	153	2	0	171	28	246	0	1	275
14	Mong Duong River	22	10	7	1	40	35	74	12	11	132
15	Cat Ba Island	0	0	0	0	0	0	0	0	0	0
	Total	3,432	2,250	153	134	5,999	5,376	3,604	204	581	9,765
	%	57%	38%	3%	2%	100%	55%	37%	2%	6%	100%

No.	Sub-catchment Area	SS (kg/day)					T-N (kg/day)				
		Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total
1	Mip River	160	14	231	68	473	45	0	18	1	67
2	Hung Thang Basin	266	0	70	49	385	72	0	8	27	107
3	Bai Chay Basin	791	14	45	0	850	234	1	8	7	250
4	Troi River	1,470	4,138	118	-399	5,327	414	1,013	21	98	1,546
5	Man River	50	219	72	2462	2,803	16	34	6	108	164
6	Dien Vong River	745	61	152	2650	3,608	256	1	24	43	324
7	Hong Gai North Basin	2,723	52	105	-313	2,567	783	1	8	27	819
8	Hong Gai South Basin	1,421	1	55	10.00	1,487	405	0	0	11	416
9	Ha Tu Basin	443	1,652	176	2,653	4,929	135	18	16	44	213
10	Cam Pha West Basin	714	193	40	2,783	3,730	159	31	0	33	253
11	Cam Pha Central Basin	147	291	30	826	1,294	36	33	0	12	81
12	Cam Pha East Basin	49	1,696	20	892	2,657	9	139	0	19	167
13	Cua Ong Basin	42	397	15	539	993	9	161	0	5	175
14	Mong Duong River	56	697	52	3,151	3,956	9	16	8	66	99
15	Cat Ba Island	0	0	0	0	0	0	0	0	0	0
	Total	9,052	9,425	1,181	15,371	35,059	2,615	1,445	117	501	4,681
	%	26%	27%	3%	44%	100%	56%	31%	2%	11%	100%

No.	Sub-catchment Area	T-P (kg/day)				
		Dom.	Ind.	Live.	Non-S.	Total
1	Mip River	0	0	24	0	24
2	Hung Thang Basin	10	0	0	22	32
3	Bai Chay Basin	24	0	9	6	39
4	Troi River	50	144	16	91	301
5	Man River	0	3	8	65	76
6	Dien Vong River	36	1	24	7	68
7	Hong Gai North Basin	100	1	0	25	126
8	Hong Gai South Basin	50	0	0	10	60
9	Ha Tu Basin	20	2	9	17	48
10	Cam Pha West Basin	20	2	0	6	28
11	Cam Pha Central Basin	0	2	0	6	8
12	Cam Pha East Basin	0	3	9	9	21
13	Cua Ong Basin	0	17	0	1	18
14	Mong Duong River	0	1	9	7	17
15	Cat Ba Island	0	0	0	0	0
	Total	310	176	105	272	866
	%	36%	20%	12%	31%	100%

Source : JICA Study Team

Table 16.3.3 Increase of Pollution Loads in Sub-catchment Areas by Rank

Share of BOD Increase by sub-catchment Area

No.	Sub-catchment Area	Dom.	Ind.	Live.	Non S.	Total	Rank
4	Troi River	9.6%	29.9%	0.3%	0.6%	40.4%	1
7	Hong Gai North Basin	17.6%	0.0%	0.2%	0.3%	18.1%	2
8	Hong Gai South Basin	9.2%	0.0%	0.1%	0.1%	9.4%	3
10	Cam Pha West Basin	4.8%	1.3%	0.1%	0.1%	6.2%	4
3	Bai Chay Basin	5.1%	0.0%	0.1%	0.1%	5.3%	5
6	Dien Vong River	3.4%	0.0%	0.4%	0.0%	3.9%	6
9	Ha Tu Basin	2.9%	0.2%	0.4%	0.2%	3.7%	7
13	Cua Ong Basin	0.3%	2.6%	0.0%	0.0%	2.9%	8
11	Cam Pha Central Basin	1.0%	1.3%	0.1%	0.1%	2.5%	9
5	Man River	0.2%	1.4%	0.2%	0.4%	2.2%	10
2	Hung Thang Basin	1.7%	0.0%	0.1%	0.3%	2.1%	11
12	Cam Pha East Basin	0.3%	1.2%	0.0%	0.1%	1.7%	12
1	Mip River	0.7%	0.0%	0.4%	0.0%	1.1%	13
14	Mong Duong River	0.4%	0.2%	0.1%	0.0%	0.7%	14
15	Cat Ba Island	0.0%	0.0%	0.0%	0.0%	0.0%	15
	Total	57.2%	38.0%	2.6%	2.2%	100.0%	

Share of COD Increase by sub-catchment Area

No.	Sub-catchment Area	Dom.	Ind.	Live.	Non S.	Total	Rank
4	Troi River	9.0%	24.2%	0.2%	1.8%	35.2%	1
7	Hong Gai North Basin	16.4%	0.1%	0.2%	0.7%	17.3%	2
8	Hong Gai South Basin	8.5%	0.0%	0.1%	0.2%	8.9%	3
10	Cam Pha West Basin	4.4%	1.3%	0.1%	0.2%	5.9%	4
6	Dien Vong River	4.6%	0.1%	0.3%	0.1%	5.1%	5
3	Bai Chay Basin	4.8%	0.0%	0.1%	0.1%	5.0%	6
12	Cam Pha East Basin	0.3%	4.4%	0.1%	0.2%	5.0%	7
9	Ha Tu Basin	2.7%	0.7%	0.3%	0.3%	4.0%	8
5	Man River	0.3%	1.4%	0.1%	1.4%	3.3%	9
13	Cua Ong Basin	0.3%	2.5%	0.0%	0.0%	2.8%	10
11	Cam Pha Central Basin	1.0%	1.4%	0.1%	0.2%	2.6%	11
2	Hung Thang Basin	1.6%	0.0%	0.2%	0.6%	2.3%	12
14	Mong Duong River	0.4%	0.8%	0.1%	0.1%	1.4%	13
1	Mip River	1.0%	0.0%	0.3%	0.0%	1.3%	14
15	Cat Ba Island	0.0%	0.0%	0.0%	0.0%	0.0%	15
	Total	55.1%	36.9%	2.1%	5.9%	100.0%	

Share of SS Increase by subcatchment Area

No.	Sub-catchment Area	Dom.	Ind.	Live.	Non S.	Total	Rank
4	Troi River	4.2%	11.8%	0.3%	1.1%	15.2%	1
9	Ha Tu Basin	1.3%	4.7%	0.5%	7.6%	14.1%	2
14	Mong Duong River	0.2%	2.0%	0.1%	9.0%	11.3%	3
10	Cam Pha West Basin	2.0%	0.6%	0.1%	3.9%	10.6%	4
6	Dien Vong River	2.1%	0.2%	0.4%	7.6%	10.3%	5
5	Man River	0.1%	0.6%	0.2%	7.0%	8.0%	6
12	Cam Pha East Basin	0.1%	4.8%	0.1%	2.5%	7.6%	7
7	Hong Gai North Basin	7.8%	0.1%	0.3%	0.9%	7.3%	8
8	Hong Gai South Basin	4.1%	0.0%	0.2%	0.0%	4.2%	9
11	Cam Pha Central Basin	0.4%	0.8%	0.1%	2.4%	3.7%	10
13	Cua Ong Basin	0.1%	1.1%	0.0%	1.5%	2.8%	11
3	Bai Chay Basin	2.3%	0.0%	0.1%	0.0%	2.4%	12
1	Mip River	0.5%	0.0%	0.7%	0.2%	1.3%	13
2	Hung Thang Basin	0.8%	0.0%	0.2%	0.1%	1.1%	14
15	Cat Ba Island	0.0%	0.0%	0.0%	0.0%	0.0%	15
	Total	25.9%	26.9%	3.4%	43.8%	100.0%	

Share of T-N Increase by Sub-catchment Area

No.	Sub-catchment Area	Dom.	Ind.	Live.	Non S.	Total	Rank
4	Troi River	8.8%	21.6%	0.4%	2.1%	33.0%	1
7	Hong Gai North Basin	16.7%	0.0%	0.2%	0.6%	17.5%	2
8	Hong Gai South Basin	8.7%	0.0%	0.0%	0.2%	8.9%	3
6	Dien Vong River	5.5%	0.0%	0.5%	0.9%	6.9%	4
10	Cam Pha West Basin	4.0%	0.7%	0.0%	0.7%	5.4%	5
3	Bai Chay Basin	5.0%	0.0%	0.2%	0.1%	5.3%	6
9	Ha Tu Basin	2.9%	0.4%	0.3%	0.9%	4.6%	7
13	Cua Ong Basin	0.2%	3.4%	0.0%	0.1%	3.7%	8
12	Cam Pha East Basin	0.2%	3.0%	0.0%	0.4%	3.6%	9
5	Man River	0.3%	0.7%	0.1%	2.3%	3.5%	10
2	Hung Thang Basin	1.5%	0.0%	0.2%	0.6%	2.3%	11
14	Mong Duong River	0.2%	0.3%	0.2%	1.4%	2.1%	12
11	Cam Pha Central Basin	0.8%	0.7%	0.0%	0.3%	1.7%	13
1	Mip River	1.0%	0.0%	0.4%	0.0%	1.4%	14
15	Cat Ba Island	0.0%	0.0%	0.0%	0.0%	0.0%	15
	Total	55.9%	30.9%	2.5%	10.7%	100.0%	

Share of T-P Increase by Sub-catchment Area

No.	Sub-catchment Area	Dom.	Ind.	Live.	Non-S.	Total	Rank
4	Troi River	5.8%	16.6%	1.8%	10.5%	34.8%	1
7	Hong Gai North Basin	11.5%	0.1%	0.0%	2.9%	14.5%	2
5	Man River	0.0%	0.3%	0.9%	7.5%	8.8%	3
6	Dien Vong River	4.2%	0.1%	2.8%	0.8%	7.9%	4
8	Hong Gai South Basin	5.8%	0.0%	0.0%	1.2%	6.9%	5
9	Ha Tu Basin	2.3%	0.2%	1.0%	2.0%	5.5%	6
3	Bai Chay Basin	2.8%	0.0%	1.0%	0.7%	4.5%	7
2	Hung Thang Basin	1.2%	0.0%	0.0%	2.5%	3.7%	8
10	Cam Pha West Basin	2.3%	0.2%	0.0%	0.7%	3.2%	9
1	Mip River	0.0%	0.0%	2.8%	0.0%	2.8%	10
12	Cam Pha East Basin	0.0%	0.3%	1.0%	1.0%	2.4%	11
13	Cua Ong Basin	0.0%	2.0%	0.0%	0.1%	2.1%	12
14	Mong Duong River	0.0%	0.1%	1.0%	0.8%	2.0%	13
11	Cam Pha Central Basin	0.0%	0.2%	0.0%	0.7%	0.9%	14
15	Cat Ba Island	0.0%	0.0%	0.0%	0.0%	0.0%	15
	Total	35.8%	20.3%	12.5%	31.4%	100.0%	

Source : JICA Study Team

FIGURES

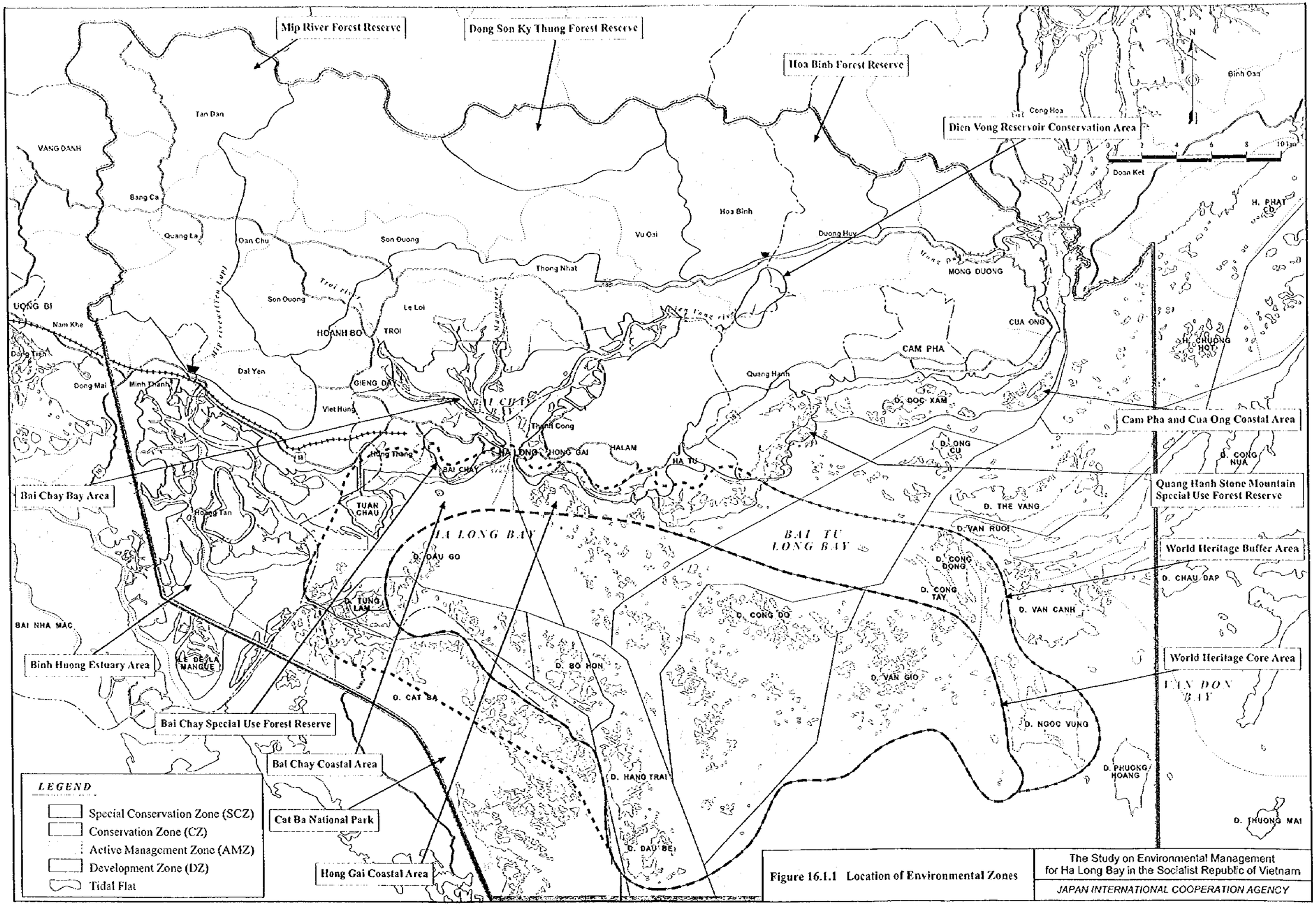


Figure 16.1.1 Location of Environmental Zones

The Study on Environmental Management for Ha Long Bay in the Socialist Republic of Vietnam

JAPAN INTERNATIONAL COOPERATION AGENCY

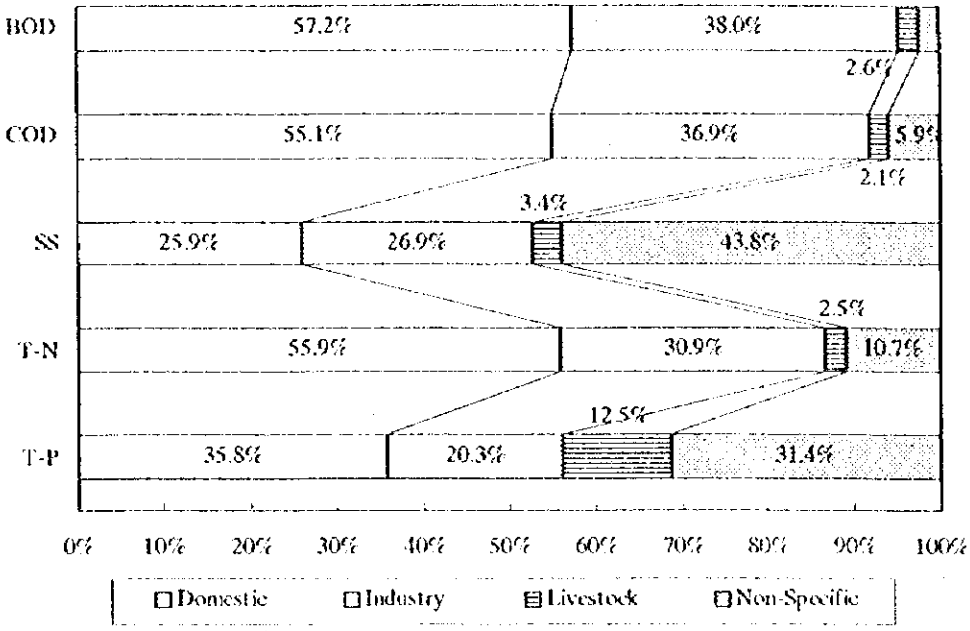
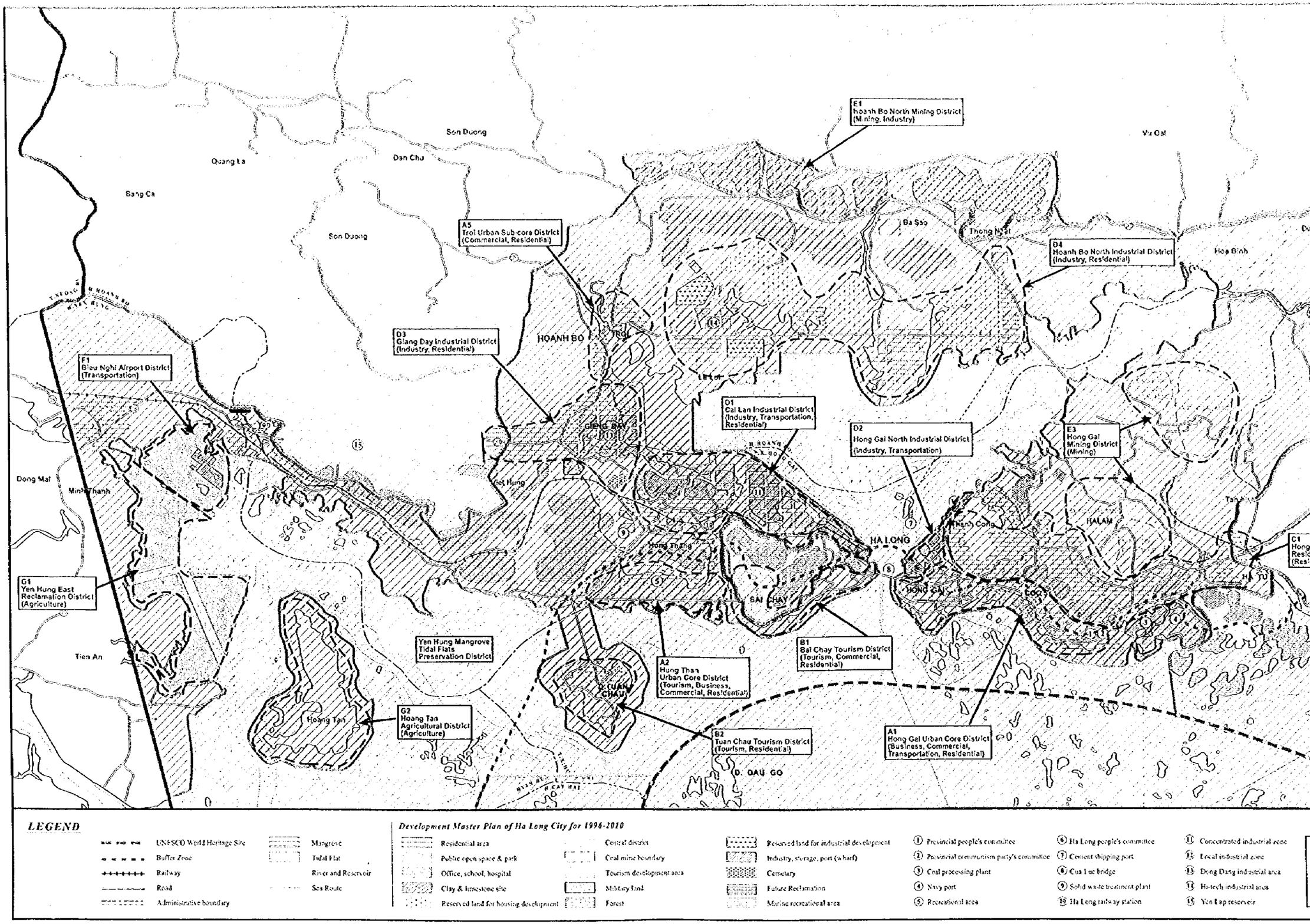


Figure 16.3.1 Share of Pollutant Increases by Pollution Source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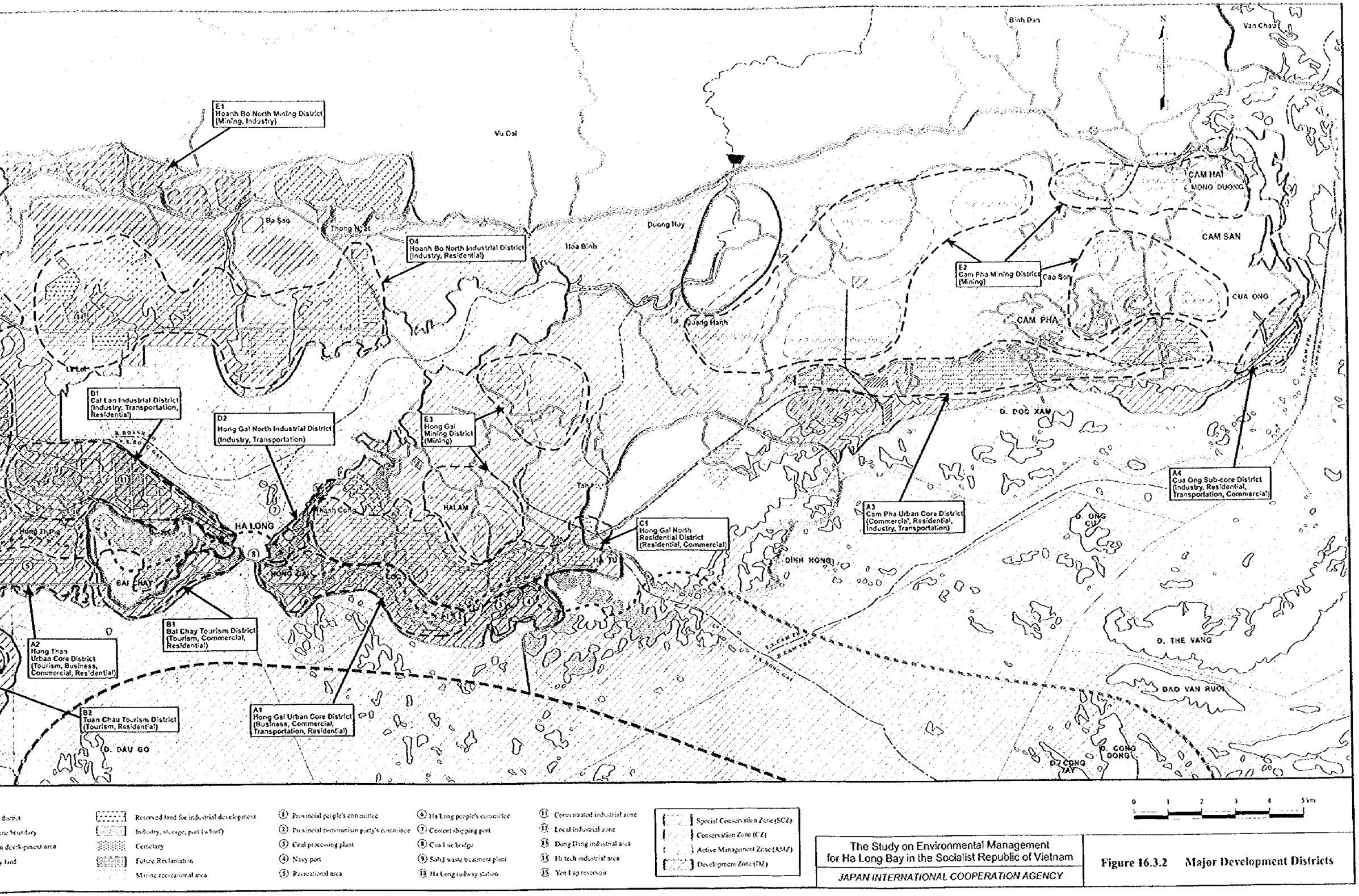
Hoanh Bo North Mining District
(Mining, Industry)
Son Duong
Dan Chu
Quang La
Bang Ca
Son Duong
Yen Dat
A5
Trol Urban Sub-core District
(Commercial, Residential)
Ba Sao
Thong Nhat
D4
Hoanh Bo North Industrial District
(Industry, Residential)
Hoa Binh
D3
Giang Day Industrial District
(Industry, Residential)
HOANH BO
F1
Bieu Nghi Airport District
(Transportation)
D1
Cai Lan Industrial District
(Industry, Transportation,
Residential)
D2
Hong Gai North Industrial District
(Industry, Transportation)
E3
Hong Gai
Mining District
(Mining)
GIENG DAY
Dong Mai
Minh Thanh
Ket Hung
Tan
HALAM
Hung Thang
HA LONG
Hanh Cong
C1
G1
Yen Hung East
Reclamation District
(Agriculture)
BAI CHAY
HONG GAI
Tien An
Yen Hung Mangrove
Tidal Flats
Preservation District
A2
Hung Thang
Urban Core District
(Tourism, Business,
Commercial, Residential)
B1
Bai Chay Tourism District
(Tourism, Commercial,
Residential)
G2
Hoang Tan
Agricultural District
(Agriculture)
Hoang Tan
O. TUAN CHAU
B2
Tuan Chau Tourism District
(Tourism, Residential)
A1
Hong Gai Urban Core District
(Business, Commercial,
Transportation, Residential)
D. DAU GO
LEGEND
UNESCO World Heritage Site
Buffer Zone
Railway
Road
Administrative boundary
Mangrove
Tidal Flat
River and Reservoir
Sea Route
Development Master Plan of Ha Long City for 1996-2010
Residential area
Public open space & park
Office, school, hospital
Clay & limestone site
Reserved land for housing development
Central district
Coal mine boundary
Tourism development area
Military land
Forest
Reserved land for industrial development
Industry, storage, port (wharf)
Cemetery
Future Reclamation
Marine recreational area
① Provincial people's committee
② Provincial communism party's committee
③ Coal processing plant
④ Navy port
⑤ Recreational area
⑥ Ha Long people's committee
⑦ Cement shipping port
⑧ Cua Luc bridge
⑨ Solid waste treatment plant
⑩ Ha Long railway station
⑪ Concentrated industrial zone
⑫ Local industrial zone
⑬ Dong Dang industrial area
⑭ Hi-tech industrial area
⑮ Yen Lap reservoir



The Study on Environmental Management for Ha Long Bay in the Socialist Republic of Vietnam

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 16.3.2 Major Development Districts

CHAPTER 17

CHAPTER 17 TARGET CONSERVATION CRITERIA

17.1 Management Targets

17.1.1 Targets Management Items

Selection of target management items and setting of conservation criteria are essential, and the proposed projects should be implemented to attain these criteria. The target management items for Goal I: Absolute Protection of the World Heritage and Goal II: Achievement of Environmental Protection for Sustainable Economic Growths can be categorized into 2 groups namely, water quality, environmental resources including national environment and landscape, while management items for Goal III: Establishment of Enforcement Capability of Environmental Management consist of technical, institutional and financial capacities. Considering the approaches and strategies of the EMP, target items were selected for formulating the EMP as follows.

(1) Water Quality

The ambient water quality is one of the important indicators which can be a representative of the environment conditions in the EMP area. Thus, conservation of water quality in the bays is indispensable in the EMP area. In order to establish countermeasures to keep the water quality in good condition, clarification of water quality parameters and setting their allowable levels or loads are required. Key target items for management are selected from the water quality indicators.

(2) Environmental Resources

1) Natural environment

Normally, forests, and fish and shellfish are defined as renewable natural resources. Also, tidal flats, mangrove swamps, and coral reefs can be considered to be environmental resources in the EMP area, because they are playing important roles in maintaining a rich environment. Thus, target items are selected from the components of natural environment.

2) Landscape

To keep the beautiful and attractive landscape of the World Heritage area is an essential element of the EMP. Landscape in the EMP area is composed of shape and conditions of islands, water conditions surrounding islands, and their combination. For keeping the landscape of the World Heritage area in good condition, conservation of natural impression without artificial landscape is very important. In order to establish countermeasures to keep attractive and unique landscape, clarification of landscape elements and setting their desirable levels are required. Thus, the elements of landscape in the World Heritage area are selected as target for the EMP.

(3) Technical, Institutional, and Financial Capacities

For an effective EMP, it is essential to strengthen the technical, institutional, and financial capacities of responsible and executing agencies. Although it is hard to set rigid numerical indexes, target items must be selected and their desirable levels for capacity building set. Thus, the target items were selected for each component of capacity building such as manpower, skills, quality, responsibility demarcation, and budget and funding sources.

17.1.2 Target Items and Indicators

In line with the establishment of goals and approaches, the following are selected as main target items and indicators for each goal set for formulating the EMP.

Target Items and Indicators for Each Goal of the EMP

Approach	Target Items	Indicators
Goal I : Absolute Protection of the World Heritage		
a) Keeping clean and clear water quality of the World Heritage area	water quality	transparency, BOD, COD, SS, T-N, T-P, oil, floating solid wastes
b) Conserving natural ecosystem and seascape of the World Heritage area	water quality	transparency, BOD, COD, SS, T-N, T-P, oil, floating solid wastes
	natural environment	coral reefs, tidal flats and mangrove swamps, fish and shellfish
	landscape	shape and conditions of islands, natural impression
c) Managing solid wastes disposal	water quality	floating solid wastes
Goal II : Achievement of Environmental Protection for Sustainable Economic Growth		
a) Controlling area wide pollution load	water quality	BOD, COD, SS, T-N, T-P
b) Conserving natural coast and tidal area	water quality	transparency, BOD, COD, SS, T-N, T-P, oil, floating solid wastes, coliform bacteria
	natural environment	tidal flats and mangrove swamps, fish and shellfish
c) Protecting forest and water quality	water quality	SS
	natural environment	forests coverage
Goal III : Establishment of Enforcement Capability of Environmental Management		
a) Capacity building of the responsible agency	technical capacity	monitoring activity, database quality, level of public awareness
	institutional capacity	responsibility demarcation, conservation criteria
	financial capacity	amount of budget, number of staff and equipment
b) Institutional set up for enforcement of the EMP	technical capacity	inspection quality, management level of measures
	institutional capacity	control power, licensing system
	financial capacity	funding sources, cost recovery system

17.2 Basic Concept for Setting Conservation Criteria

First, examination of environmental conservation level in terms of water quality for the whole EMP area was implemented by comparison of scenarios. Secondly conservation criteria of each target item by environmental zones were examined. The procedure applied for setting conservation criteria is shown in Figure 17.2.1.

17.2.1 Examination of Environmental Conservation Level

(1) Setting Scenarios for Environmental Management Level

The following three scenarios of environmental management in the future (2010) are set for water quality in the bays. The scenarios were considered based on the

current progress of countermeasures and assumed assimilative capacity in the bays. Scenario I considers only the current progress of environmental controls including planned project which will have been done by 2010, namely "without the Environmental Management Plan (without the EMP). Scenarios II and III consider the levels of the pollution loads comparable to the assumed assimilative capacity of the bays. Scenarios set are as follows:

- Scenario I: Present progress of environmental control (without the EMP).
- Scenario II: Environmental control to keep pollution loads at the present level. This scenario also includes pollution control for specific areas such as the Bai Chay beach, Hong Gai and Cam Pha areas.
- Scenario III: Environmental control to reduce the present level of pollution loads (organic and inorganic pollutants, nutrients) in order to alleviate progress of eutrophication in the bays.

(2) Possible Projects of Each Scenario

Based on the socioeconomic frame and alternatives of countermeasures set above, the possible countermeasures set for each scenario are shown below and listed in Table 17.2.1.

- Scenario I:
  - Sewage construction and management project in the Bai Chay area,
  - First stage of Ha Long City Water Supply and Sanitation Project (HWSSP),
  - Present practices of sanitation improvement,
  - Wastewater treatment to attain effluent standards for new industrial development projects including mining,
  - Present reforestation activities, and
  - Present pollution control for coal mining activities by VINACOAL.

- Scenario II:
  - Projects mentioned in Scenario I,
  - Additional sewage and solid wastes control,
  - Wastewater treatment of existing factories to attain effluent standard,

- Imposition of stringent effluent standard to the new factories
- Additional reforestation of coal mining area and other bare areas, and
- Additional pollution control for coal mining activities

- Scenario III:
  - Projects mentioned in Scenario I and II,
  - Additional sewage and solid wastes control,
  - Wastewater treatment of existing and future factories to attain more stringent effluent standards,
  - Additional reforestation of coal mining area and other bare areas, and
  - Additional pollution control for coal mining activities.

(3) Future Pollution Loads by Scenarios

Projected future runoff pollution loads of Scenarios II and III are shown in Table 17.2.2-3 (for Scenario I, see Table 14.3.1). Summarized projected runoff pollution loads are shown below:

Future Runoff Pollution Loads of Scenarios

(Units: tons/day)

Items		BOD	COD_{Mn}	SS	T-N	T-P
Present (1996)		7.2	21.9	241	15.5	6.0
Future (2010)	Scenario I	12.9	30.2	272	20.0	6.8
	Scenario II	8.7	23.7	233	18.0	6.4
	Scenario III	6.4	21.3	168	14.7	5.9

Compared with the present pollution load, total runoff pollution load in 2010 of Scenario I will be 1.8 times in BOD, 1.4 times in COD, 1.1 times in SS, 1.2 times in T-N, and 1.1 times in T-P. While, Scenario III, total runoff pollution loads in 2010 will be about 0.9 times in BOD, COD, T-N, and T-P, and 0.7 in SS.

(4) Future Water Quality by Scenarios

The predicted water quality of Scenario I is shown in Figure 14.3.5 ~ 14.3.14 in Chapter 14 as that of "without an Environmental Management Plan". As for the predicted water quality of Scenario II and III is shown in Figure 17.2.2 ~ 17.2.5.

1) Water quality of Scenario I (without the EMP)

The causeway toward Tuan Chau island clearly separated the distributions of all water quality parameters by Scenario I. The distribution of such separated water quality parameters showed that the causeway prevented the water exchange through the northern channel of Tuan Chau island resulting in higher concentrations in eastern side of the separated sea where pollution loads were distributed more than the western side.

2) Water quality of Scenario II (current pollution load conditions)

The concentrations of water quality parameters were lower than those by Scenario I inside and near the mouth of Bai Chay bay. No significant difference of the concentration was found in other areas between the results by Scenario II and those by Scenario I.

3) Water quality of Scenario III (reduced pollution load conditions)

The concentrations of all water quality parameters by Scenario III were the lowest in three scenarios inside and near the mouth of Bai Chay bay. The high concentrations of SS around the load points of Cam Pha by Scenario I and II were not found in the results by Scenario III. In offshore area, no significant difference of the concentration was found in all water quality parameters by Scenario III compared to those by Scenario I and II.

(5) Indicative Costs of Possible Projects by Scenarios

For comparative analysis of scenarios, environmental measures which will reduce runoff pollution load directory were selected among the several possible measures. Selected measures were domestic and industrial wastewater management (sanitation exclusive solid wastes management), and measures for mining, tourism and environmental resources.

Indicative costs for the possible projects by scenario relating to the water quality directly are compared in the next table by scenarios. Some costs differ by scenarios, while the others are common for all scenarios. Total indicative costs of the projects range from US$ 35×10^6 of Scenario I to US$ 191×10^6 of Scenario III.

(Unit: US$ × 10^6)

Cost Items	Scenario I	Scenario II	Scenario III
1. Sanitation	5.5	64.3	132.0
2. Environmental Measures for Mining	23.1	28.5	40.8
3. Environmental Measures for Tourism	1.2	1.2	1.2
4. Environmental Measures for Natural Environment	5.5	7.5	17.0
Total	35.3	101.5	191.0

(6) Comparison of Scenarios

The projected future water quality by the simulation model revealed effectiveness of each scenario to the ambient water quality in the bays. In the case of Scenario I, the water quality for example COD_{Mn} in Bai Chay bay was estimated to increase from 4 mg/ℓ to 5 or 6 mg/ℓ in upper layer. The increase in COD_{Mn} will be most pronounced in the coastal area from Tuan Chau to Hong Gai areas, and it will extend out to the World Heritage core area. Thus, the projects in Scenario I are not enough to prevent water quality deterioration in the World Heritage core area, so more stringent countermeasures are required. In Scenario II, almost same level of the water quality as the present was projected.

In case of Scenario III with nearly the double cost of Scenario II, little changes of water quality were identified compared with Scenario II. These almost full-scale countermeasures can not improve the water quality in the bays drastically, especially in the World Heritage core area. This is because more than 50% of runoff pollution loads, SS and nutrients, arise from non-specific pollution sources which can hardly be control. It follows from this that the Scenario II level is relatively efficient one to conserve water quality in the bays.

Therefore, it is recommended that the Scenario II level, namely current pollution load level, be applied to establish management level of the whole MEP area from the viewpoint of efficiency of the projects.

17.2.2 Basic Considerations of Conservation Criteria by Target Items

Based on the examined management level, the conservation criteria is set corresponding to the utilization of the areas. For example, relatively stringent criteria may be required for Special Conservation zone (SCZ) such as the World Heritage core area. Those of CZ are also necessary to set stringent criteria next to

SCZ. Therefore, applicable levels and classifications for setting the criteria should be based on the environmental zones. The following are basic concepts for setting conservation criteria of target items.

(1) Water Quality

In Vietnam, there is a set of ambient water quality standards authorized by GOV, such as the Coastal Water Quality Standard. However, they can not be directly applied to the conservation criteria for the EMP area due to their rather weak strictness of water quality values. Thus, an appropriate conservation criterion should be determined based on suitable water utilization of each environmental zone in the bays. The next table shows applicable level of water quality corresponding to the environmental zones.

Environmental zone	Applicable level	Main applied area
SCZ	Conservation of aesthetic and ecosystem	World Heritage core area, coral reef
SCZ, AMZ	Conservation of bathing and fishery ground	World Heritage buffer area, fishery grounds, and bathing beaches
DZ, CZ	Conservation of living environment	Other areas

As a result of comparative analysis of scenarios, the present water quality levels could be applied for the management criteria on the whole. This is also grounded on the fact that the present water quality level in the bays was one of reasons to be inscribed in the World Heritage list.

More stringent criteria compared with the present water quality levels, however, are needed for some specific items and areas. For examples, floating solid wastes and oil slick should be controlled more strictly in order to conserve the beautiful seascape. For the areas such as Bai Chay area where a bathing beach is located, and Hong Gai and Cam Pha coastal areas where the present water is rather deteriorated by domestic or coal mining wastewater, the water quality should be improved. In particular, the water quality of the Bai Chay beach area shall be improved so it has good sanitary conditions and is more attractive for tourists.

(2) Environmental Resources

1) Natural Environment

a) Forest

The forest areas having significant functions of conservation of water resources and biodiversity are designated as the protected forest. The protected forest is managed in the same way as the present by the management of the Forest Protection Agency (FPA) and the Department of Agriculture and Rural Development (DARD). Other forest should be managed to conserve current forest vegetation ratio. The ratio can be discussed from the aspect of controlling SS runoff.

b) Tidal flats and mangrove swamps

The results of the Field Survey suggests that the tidal flats and mangrove swamps in the EMP area have a high productivity, and functions of purifying water quality and providing nursery ground. Considering these roles in the bays, it is proposed that management criteria be set so as to keep or increase these functions.

c) Coral reefs

Management criteria shall be on the basis of the distribution, species composition, and living coral cover considering the present conditions of coral reefs in the EMP area. It is recommended to manage the coral reefs so as not to worsen the current condition.

d) Fish and shellfish

Since fish and shellfish can be regarded as indexes of marine environment as well as economical values, it is recommended that their management shall be based on species composition and the amount of catches. Considering their present conditions, management criteria shall be set so as not to worsen the current condition.

2) Landscape

The landscape elements of the World Heritage area should be conserved as they are by preventing degradation activities and pressures. Therefore, the present levels and quality of the elements are regarded as the criteria.

(3) Technical, Institutional, and Financial Capacities

To judge the efforts taken for environmental management and see the progress, it is necessary to set clear target items and management criteria. At present, technical, institutional, and financial capacities for environmental management on Ha Long bay are not enough. Thus, the criteria should be set based on the desirable levels of each component. In particular, a scope of required monitoring activities including skills, equipment, financial back support should be taken into consideration.

17.3 Items and Classification of Conservation Criteria

In order to set target conservation criteria of the EMP area, the following items related to water quality and environmental resources are selected as the actual and quantitative management indexes considering the environmental zones. As for criteria of technical, institutional, and finical capacities, a qualitative approach is considered to be suitable for setting criteria.

17.3.1 Water Quality

(1) Management Indicators

The water quality is to be the most important and indispensable index for setting conservation criteria. The following 9 water quality indicators are selected as the actual index of the EMP.

1) Transparency

Transparency is an integrated index of clearness, visibility, turbidity, SS, and plankton numbers, and is easy to monitor by a Secchi disk. However, it has some

limitations to apply to shallow waters and to detect differences by water layer of the bay.

2) BOD and COD_{Mn}

BOD and COD_{Mn} are indexes of organic pollution mainly caused by human activities in the hinterland area and by primary production in the bay. These two indexes are also important for pollution load calculation.

3) T-N and T-P

T-N and T-P are indexes of nutrients causing eutrophication, and have close implication with primary production of the bay.

4) SS

SS is also an index of clearness, visibility, turbidity, and plankton numbers, and is an important substance of pollution load calculation. Moreover, it can make up for limitations of the transparency.

5) DO and pH

DO and pH are indexes standing for general conditions of water especially of habitat conditions for aquatic organisms.

6) Oil, Floating Solid Wastes, and Coliform Bacteria

These are indexes standing for nuisance issues of the bay from usage of natural resources, such as tourism, bathing, recreation, and landscape.

(2) Implication with Environmental Zones

1) SCZ

SCZ in the bays corresponds to the World Heritage core and buffer areas. The current mass balance of pollution loads of BOD, T-N, T-P and SS in this area revealed that the amount of load flowing into the bays from surrounding areas is fairly small, compared with the load of a primary production, recovery, or stirring up from the bottom as shown below. These are almost less than 1% in BOD, T-N, and SS. This means that the current water quality conditions of the bays are under the wide scale of natural dynamic balance, and there could be little room to

improve the water quality by controlling man-made pollution loads from the hinterland area.

(Unit: tons/day)

Substance	Pollution load inflow	Primary production, elution and others	Total load
BOD	10 (0.5%)	1,480 (99.5%)	1,490 (100.0%)
T-N	16 (1.1%)	1,414 (98.9%)	1,430 (100.0%)
T-P	6 (6.0%)	94 (94.0%)	100 (100.0%)
SS	200 (0.1%)	137,800 (99.9%)	138,000 (100.0%)

Although the bay's water quality of SCZ would be mesotrophic state, the current environmental status is considered in rather good condition because of the existence of coral reefs and fishing grounds in it. Moreover, a result of questionnaire survey conducted by the JICA study team shows that more than 80% of tourists interviewed are satisfied with the current water quality and landscape of the World Heritage area. Therefore, the current water quality conditions of the bay is to be a conservation criteria in SCZ.

Since the current water quality conditions of the World Heritage core and buffer areas are quite different from the western and eastern part of the area as shown below, the water quality conservation criteria should be set for the two areas.

Substance	Western part	Eastern part
Transparency (m)	2.7	3.7
BOD (mg/ℓ)	1.7	1.1
COD (mg/ℓ)	7.3	4.6
T-N (mg/ℓ)	1.24	1.09
T-P (mg/ℓ)	0.54	0.49
SS (mg/ℓ)	4.8	4.0

2) CZ

CZ is mostly located in the eastern part of the bay surrounding the World Heritage core and buffer areas. This means that CZ is to be an area to protect SCZ and to keep almost same water quality level of the eastern part of the bay. Moreover, it also has the same characteristics of pollution load inflow as in SCZ as shown below. Therefore, the conservation criteria of CZ should be set based on the current water quality level of the bay.

(Unit: tons/day)

Substance	Pollution load inflow	Primary production, elution and others	Total load
BOD	2 (3.5%)	55 (96.5%)	57 (100.0%)
T-N	4 (2.5%)	153 (97.5%)	157 (100.0%)
T-P	1 (8.3%)	11 (91.7%)	12 (100.0%)
SS	72 (0.0%)	147,186 (99.9%)	147,258 (100.0%)

3) AMZ

AMZ in the bay consists of five important areas, namely a) Bai Chay coastal area, b) Hong Gai coastal area, c) Bai Chay bay, d) Cam Pha and Cua Ong area, and e) Binh Huong estuary area mostly located along the coastal line. The conservation criteria should be set considering the location, characteristics of pollution mechanism, and current and planned development activities of these areas.

a) Bai Chay coastal area

This area is about 25 km^2 which includes the Bai Chay beach, Hong Thang area, and Tuan Chau island up to a causeway to the Tuan Chau island, and it will be mainly used for tourism development. International and domestic tourists will be easy to contact seawater directly from beach and boat. The conservation criteria must be set to keep and enhance the tourism potential of the natural environment such as sea bathing, clean and clear coastal beach, beautiful land and seascape. It is also a part of the World Heritage buffer area. Therefore, the conservation criteria should be more stringent than those of other areas in AMZ such as the Hong Gai, and the Cam Pha and Cua Ong coastal areas.

Considering the current water uses for bathing during the summer season, the current water quality in this area could be acceptable for recreational uses. In fact, the current water quality meets the Coastal Water Quality Standard in Vietnam (TCVN5943). However, the current water quality is not suitable for bathing especially for coliform number, compared with the international standards such as the Japanese Standards of Bathing Purpose Water (less than 1,000 MPN/100 mℓ). This is mainly caused by the leakage of wastewater along the wharves, and it will require enough disinfection of treated wastewater. Moreover, solid wastes are floating on the sea and

washing on to the shore. Thus, improvement of sanitary conditions is strongly required in this area as well as pollution load control.

According to the result of current mass balance of pollution loads in this area, the load flowing into this area is mostly coming from the Cua Luc strait by sea current. This means that the current water quality conditions of this area fully depend on the water quality of Bai Chay bay, and they could be manageable by controlling the loads from the strait. Thus, the conservation criteria in this area should have close relationship with the conservation criteria of Bai Chay bay.

Transparency and SS would be difficult to improve because of stirring up seabed sediment by waves and navigation boats. Considering actual sea bathing activities in the area, the current transparency and SS values would not strongly affect the local people and domestic tourists. Therefore, the conservation criteria of transparency and SS are set based on the current water quality.

(Unit: tons/day)

Substance	Pollution load inflow from hinterland	Pollution load inflow from Cua Luc strait	Primary production, elution and others	Total load
BOD	0.3 (1.0%)	4.2 (14.7%)	24.1 (84.3%)	28.6 (100.0%)
T-N	0.3 (0.9%)	5.7 (16.7%)	28.1 (82.4%)	34.1 (100.0%)
T-P	0.1 (1.1%)	2.3 (26.1%)	6.4 (72.8%)	8.8 (100.0%)
SS	0.3 (0.0%)	14.7 (0.3%)	1,780.0 (99.7%)	1,795.0 (100.0%)

b) Hong Gai coastal area

This area is about 20 km^2 which includes Hong Gai beach, Cot 5 coal port area, and Nam Cau Trang coal port area, and it will be mainly used for urban development and coal shipping.

Since the current water quality has been degraded mainly due to the discharge of domestic wastewater from densely populated area, the first priority should be put on water quality improvement in the near shore area especially in organic substance such as BOD. This area is also a part of the World Heritage buffer area. Thus, the conservation criteria should be set at a similar level of the Bai Chay coastal area to prevent the water quality

deterioration in the buffer area. However, a water quality level of sea bathing is not required because of no plans to use the area for tourism purpose.

Since the current mass balance of pollution loads in this area shows same characteristics as the Bai Chay coastal area as shown below, its specific conservation criteria is to be set considering the criteria of the Bai Chay coastal area and Bay Chay bay.

(Unit: tons/day)

Substance	Pollution load inflow from hinterland	Pollution load inflow from Cua Luc strait	Primary production, elution and others	Total load
BOD	0.5 (1.7%)	2.1 (7.2%)	26.7 (91.1%)	29.3 (100.0%)
T-N	0.5 (1.4%)	2.8 (8.0%)	31.7 (90.6%)	35.0 (100.0%)
T-P	0.1 (1.0%)	1.2 (12.1%)	8.6 (86.9%)	9.9 (100.0%)
SS	2.7 (0.8%)	7.3 (2.2%)	327.0 (97.0%)	337.0 (100.0%)

c) Bai Chay bay

This area is about 47 km^2 which includes whole Bai Chay bay and its coastal areas. Many development projects are planned to be implemented in this area, so the environment will be threaten by the impacts of pollution load increase and purification capacity decrease.

According to the current mass balance of pollution loads shown below, the amount of loads flowing into this area account for 5% in BOD, 12% in T-N, 15% in T-P, and 10% in SS. This means that the water quality conditions could be changeable by controlling man-made pollution load from the development activities in its hinterland.

(Unit: tons/day)

Substance	Pollution load inflow			Pollution load outflow through the Cua Luc strait
	Pollution load inflow from hinterland	Primary production, elution and others	Total load	
BOD	2.9 (4.6%)	59.6 (95.4%)	62.5 (100.0%)	6.3
T-N	7.0 (12.0%)	51.5 (88.0%)	58.5 (100.0%)	8.5
T-P	2.9 (14.8%)	16.7 (85.2%)	19.6(100.0%)	3.5
SS	94.0 (10.2%)	828.0 (89.8%)	922.0 (100.0%)	22.0

Although the current water quality of the bay is rather good, it is easily degraded due to its semi-closed geographic condition. Moreover, the water quality of the bay has close link with that in the Bai Chay coastal area and the Hong Gai coastal area because of the pollution load from the Cua Luc

strait. In order to attain the conservation criteria set for the Bai Chay coastal area and the Hong Gai coastal area, the current pollution load to the bay can not be allowed to increase. Consequently, the conservation criteria of the bay is set based on the present water quality level.

d) Cam Pha and Cua Ong coastal area

This area is about 45 km^2 which includes the coastal area of Quang Hanh, Cam Pha, and Cua Ong including Vung Duc and Cua Ong coal ports, and the Mong Duong river mouth area. This area will be mainly used for urban development and coal shipping.

The current water quality in the offshore area is in rather good condition. In the near shore area, however, the water quality is fairly degraded by the pollution load from coal mining areas especially in SS. The values of SS usually exceed the Coastal Water Quality Standard in Vietnam in the near shore area. Although most SS load is expected to be derived from stirred up activities by waves, it is necessary to control SS run off caused by coal mining activities and to prevent expansion of water areas which have exceeding SS values in this area.

Much stringent conservation criteria would not be required for this area because it is apart from the World Heritage buffer area. Therefore, its conservation criteria should be set considering that of CZ.

(Unit: tons/day)

Substance	Pollution load inflow	Primary production, elution and others	Total load
BOD	2.0 (7.8%)	23.8 (92.2%)	25.8 (100.0%)
T-N	3.5 (3.2%)	105.5 (96.8%)	109.0 (100.0%)
T-P	1.0 (20.0%)	4.0 (80.0%)	5.0 (100.0%)
SS	72.0 (1.2%)	5,944.0 (98.8%)	6,016.0 (100.0%)

e) Binh Huong estuary area

The Binh Huong estuary area is about 110 km^2 which includes the Mip river mouth area, Minh Thanh, Hoang Tan, and the western part of the Tuan Chau island. The tidal flats in this area, including mangrove swamps, keep good ecological conditions at present. Not so many development projects are planned in this area, however, reclamation of tidal flats for expansion of

agricultural lands could have major environmental impacts in future. Therefore, the conservation criteria should be set mainly for protection of precious ecosystem and biodiversity considering current water quality conditions.

According to the current mass balance of pollution loads, this area receives relatively small amount of pollution load inflow.

(Unit: tons/day)

Substance	Pollution load inflow	Primary production, elution and others	Total load
BOD	0.8 (1.0%)	81.5 (99.0%)	82.3 (100.0%)
T-N	2.3 (2.8%)	199.5 (97.2%)	201.8 (100.0%)
T-P	1.2 (3.6%)	32.5 (96.4%)	33.7 (100.0%)
SS	32.0 (2.7%)	1,148.0 (97.3%)	1,180.0 (100.0%)

It should be noted that it seems to have more room for self-purification capacity compared with other areas in AMZ, because the balance of pollution loads shows surplus in BOD, T-N, and T-P. Since a large scale development is not planned at present, this situation will last as long as there are no significant decrease of natural tidal flats.

(Unit: tons/day)

Area	Substance	(1) Pollution load inflow	(2) Pollution load outflow	Balance (1) – (2)
a) Bai Chay Coastal Area	BOD	4.5	3.0	1.5
	T-N	6.0	3.2	2.8
	T-P	2.4	2.7	-0.3
b) Hong Gai Coastal Area	BOD	2.6	2.0	0.6
	T-N	3.3	3.4	-0.1
	T-P	1.3	1.8	-0.5
c) Bai Chay Bay	BOD	2.9	6.3	-3.4
	T-N	7.0	8.5	-1.5
	T-P	2.9	3.5	-0.6
d) Cam Pha and Cua Ong Coastal Area	BOD	2.0	5.5	-3.5
	T-N	3.5	2.1	1.4
	T-P	1.0	0.9	0.1
e) Binh Huong Estuary Area	BOD	0.8	0.7	0.1
	T-N	2.3	1.8	0.5
	T-P	1.2	0.6	0.6

4) DZ

DZ is located on the hinterland of the bays. The Inland Water Quality Standard of Vietnam (TCVN5942-1995) can be applied to the surface water there as well as SCN and CZ.

There is also the Industrial Wastewater Effluent Standard (TCVN 5945-1995) in Vietnam. Values of parameters and maximum allowable concentration of substance in industrial wastewater before being discharged into the water bodies are stipulated in it. There are three levels from A to C in the Effluent Standers Standard A is most stringent one that is imposed on the wastewater to be discharged into the water bodies used for sources of domestic water supply. Standard B is relatively weak than A, which applied to the wastewater discharged into the water bodies used for navigation, irrigation, bathing, aquatic breeding and cultivation. These effluent standards should be applied to the industries as conservation criteria.

Basically, Standards B can be applied in the EMP area. However, if planned two industrial zones, such as Cai Lan and Hoanh Bo zones, discharge their wastewater with Standard B, total runoff pollution load into Bai Chay bay will exceed the present level by that from them. Therefore, more stringent effluent standard will be required on industries in Bai Chay bay catchment. Considering technically possible treatment level, Standard A could be applied in Bai Chay bay catchment.

In terms of treated domestic wastewater by sewerage system, the Vietnamese standard should be attained too, exclusive of Bai Chay bay catchment. As indicated by pollution mechanism in Bai Chay bay such as pollution loads moving out through the Cua Luc strait is bigger than that from catchment, primary production should be controlled to prevent increasing in pollution load from the Cua Luc strait. For that, treatment of nutrients is required in Bai Chay bay catchment considering technically practical treatment level.

17.3.2 Environmental Resources

(1) Natural Environment

The following four components of the natural environment are selected as the management indexes of the EMP:

- Forest coverage ratio of the hinterland area
- Acreage of tidal flats in the coastal area
- Distributions species composition, and living coal cover

- Species composition and amount of catches of fish and shellfish of the fishery grounds

1) Forest coverage ratio

Forest coverage ratio is an index of soil erosion, SS runoff, biodiversty, and conservation of water resources of the hinterland area. It is also one of the provincial environmental targets set by QNPC. For setting forest coverage ratio as conservation criteria, the present and projected future conditions of forest coverage including scrub and grass lands, namely green coverage, were identified. Based on the projected future land use pattern, necessary green coverage area to prevent increasing runoff SS by each sub-catchment were estimated and summarized below.

(Unit: km^2)

Sub-catchment	Current conditions			Future conditions		
	a) Basin area	b) Present forest area	% = b) / a)	c) Future green area without the EMP	d) Green area to protect SS runoff	e) Area to be recovered
1) Mip river basin	254	183	72	183	183	0
2) Hung Thang basin	8	7	88	7	7	0
3) Bai Chay basin	6	4	67	3	3	0
4) Troi river basin	197	162	82	154	156	2
5) Man river basin	120	98	82	91	93	2
6) Dien Vong river basin	251	209	83	199	209	10
7) Hong Gai north basin	13	8	62	4	5	1
8) Hong Gai south basin	7	3	43	2	2	0
9) Ha Tu basin	29	18	62	13	16	3
10) Cam Pha west basin	31	26	84	24	25	1
11) Cam Pha central basin	15	4	27	3	4	1
12) Cam Pha east basin	11	4	36	3	4	1
13) Cua Ong basin	9	6	67	6	6	0
14) Mong Duong basin	82	61	74	55	61	6
15) Cat Ba island	130	126	97	126	126	0
Total	1,163	921	79	873	900	27

Note: 1) Forest area includes scrub and grass lands
2) Present forest area was obtained by satellite image analysis by JICA study team.

Looking at green coverage area by environmental zone, the present area and its ratio are as follows:

SCZ: 464 km^2 (green coverage ratio in SCZ: 94%)

CZ: 208 km^2 (green coverage ratio in CZ: 85%)

DZ: 249 km^2 (green coverage ratio in DZ: 59%)

Since most green coverage loss by development projects, expansion of coal mining areas, and urbanization, will happen in DZ, the present green coverage in SCZ and CZ are assumed to be kept at present level for setting conservation criteria. Total loss of the green coverage will be about 48 km^2. Thus, attention for recovering green coverage should be paid on DZ. As total required green coverage to prevent increasing runoff SS is 900km^2, the proposed conservation criteria of green coverage in DZ is 228km^2, and green coverage ratio in DZ is 52%.

2) Acreage of tidal flats and mangrove swamps

Relatively rich biomass was observed in the tidal flats and mangrove swamps in the EMP area. They purify the water and provide nursery grounds for fishery resources. But because the coastal area is relatively narrow, there has been extensive land reclamation for urban development and as well as dike construction for expansion of agricultural land or aqua-cultural ponds on tidal flats and mangrove swamps. They will be also reclaimed especially in Bai Chay bay and along Ha Long bay in the future. Therefore, management shall be focused on acreage of tidal flats and mangrove swamps. The current condition and area to be lost by 2010 are as follows:

(Unit: ha)

Environmental Zone	Area	Current conditions			Projected future conditions			
		a) Tidal flats	b) Mangrove swamps	% = b)/a)	c) Area to be reclaimed by 2010	d) Tidal flats	e) Mangrove swamps	% = e)/d)
1. SCZ	Quang Hanh	1,100	30	3	0	1,100	30	3
	Cat Ba island	20	20	100	0	20	20	100
2. AMZ	Binh Huong estuary	10,100	1,800	18	200	9,900	1,600	16
	Bai Chay coastal area	1,700	10	1	200	1,500	0	0
	Bai Chay bay	4,700	1,400	30	950	3,750	1,000	26
	Hong Gai coastal area	650	10	2	40	610	10	2
	Cam Pha and Cua Ong coastal area	2,400	10	0	280	2,120	10	0
Total		20,670	3,280	16	1,670	19,000	2,640	14

Note: 1) Tidal flat area means emergence which was obtained by topographic maps.
2) Mangrove swamp area was obtained by satellite image analysis by JICA study team.

For setting conservation criteria of tidal flats, they were classified into three categories and conservation criteria were set as shown below:

- Tidal flats in SCZ : class A
- Tidal flats with relatively high coverage ratio by mangrove swamp, more than 16% (present average mangrove coverage ratio) : class B
- Other tidal flats : class C

In tidal flats in SCZ (class A), no land reclamation is permitted so that the present area could be protected. Since tidal flats of class B also are playing important roles on marine ecosystem, fishery, and water purification in the EMP area, only existing planed land reclamation is permitted. Considering planned and proposed land reclamation area in future, 75% of present area is set as conservation criteria on other tidal flats to keep room for further plans.

As for mangrove swamps, at least the present acreage in each area should be protected to conserve their functions. In terms of mangrove swamps with relatively low coverage ratio, less than 16% which is the average coverage ratio in the EMP area, conservation criteria in these areas were set at the present average coverage ratio of 16% to improve their function together with tidal flats.

Considering these matters, conservation criteria of tidal flats and mangrove swamps set were summarized as follows:

Environmental Zone	Area	Tidal flats		Mangrove Swamp		
		Class	a) Conservation criteria (ha)	b) Conservation criteria (ha)	%= b)/a)	c) Required rehabilitation area (ha)
1. SCZ	Quang Hanh	A	1,100	180	17	150
	Cat Ba island	A	20	20	100	0
2. AMZ	Binh Huong estuary	B	9,900	1,800	18	200
	Bai Chay coastal area	C	1,300	210	16	210
	Bai Chay bay	B	3,800	1,400	37	400
	Hong Gai coastal area	C	500	80	16	70
	Cam Pha and Cua Ong coastal area	C	1,800	300	17	290
Total		-	18,420	4,000	22	1,320

3) Protection of coral reef

Coral reef is a symbol of clean and clear seawater condition. However, the most current coral reefs in the EMP area are distributed in the southern part of SCZ

only and they are categorized as poor reef with living coverage less than 25%. As discussed in Section 5.1.1, the water quality in SCZ mainly depends on natural dynamics. Thus, drastic improvement of coral reefs habitats are not expected. Considering these matters, management criteria shall be set on the basis of the present distribution, species composition, and living coral cover.

4) Protection of fish and shellfish of the fishery grounds

Since fish and shellfish can be regarded as indexes of marine environment as well as economic value, their management need to be based on species composition and the amount of catches. However, there is not enough information to grasp actual species composition and the amount of catches within the EMP area at present. Thus, attention should be paid on protecting fishing grounds including water quality to protect fish and shellfish in the EMP area. It is recommended that management criteria should be carried out by controlling of illegal fishing at the fishery grounds.

(2) Landscape

Beautiful landscape of the World Heritage area corresponding to SCZ is considered invaluable, and it is the essence of tourism potential. Since the landscape itself consists of various elements, the following four major elements are selected as indexes for the EMP.

- Shape and surface of islands
- Color and clearness of seawater
- View of natural resources
- Natural scenery

The landscape elements of the World Heritage area should be conserved as they are by preventing degradation activities and pressures. Therefore, the present levels and quality of the elements are regarded as the criteria, except for the water quality that is selected as the water quality criteria, and obstacles against natural scenery such as ships anchored in the World Heritage core area.

17.3.3 Technical, Institutional, and Financial Capacities

Built up capacities of technology, institution, and finance is essential to implement the EMP effectively and appropriately. The current situations of these capacities of DOSTE and other relating agencies, however, are not enough to implement the EMP. Thus, it is recommended that their capacities should be built up so that they can manage environment in the EMP area by themselves. The following aspects are selected:

- Technical capacity: monitoring, database management, public awareness,
- Institutional capacity: responsibility demarcation, control power, licensing system
- Financial capacity: budget, number of staff, funding sources, cost recovery system

17.4 Conservation Criteria by Environmental Zones

The conservation criteria by environmental zones are proposed for water quality, environmental resources, and landscape. They are summarized below. As for criteria of technical, institutional, and finical capacities, they should be set without regard to the environmental zones.

It should be noted that the proposed conservation criteria are not standards for the whole Vietnam, but just for the EMP area. It is recommended that QNPC and agencies concerned for implementation of the EMP should authorize the proposed conservation criteria. However, it shall be also stressed that the proposed conservation criteria are not absolute ones, so they should be revised based on reliable data to be obtained by the future monitoring activities.

17.4.1 Water Quality Conservation Criteria

(1) Sea area

Considering the significance of each environmental zone, and the current water quality and beneficial uses of water in each zone, the water quality conservation criteria are set as shown in Figure 17.4.1 and table below:

Water Quality Conservation Criteria (Sea area)

Environ. Zone	Applied area	Transparency (m)	BOD (mg/ℓ)	COD_{Mn} (mg/ℓ)	T-N (mg/ℓ)	T-P (mg/ℓ)	SS (mg/ℓ)
SCZ	Western Part	3.0	1.5	7.0	1.3	0.6	5
	Eastern Part	3.5	1.0	4.5	1.1	0.5	4
CZ	-	3.0	1.0	4.5	1.1	0.5	5
AMZ	Bai Chay coastal	0.5	1.3	7.5	1.6	0.7	15
	Hong Gai coastal	1.5	1.3	7.5	1.6	0.7	5
	Bai Chay bay	1.5	1.3	7.5	1.6	0.7	5
	Cam Pha and Cua Ong coastal	1.5	1.1	5.0	1.6	0.7	7
	Binh Huong estuary	0.5	1.3	7.5	1.6	0.7	15

Conservation criteria of DO, pH, oil slick, floating solid wastes, and fecal coliform are set based on the Japanese Coastal Waster Quality Standards. They are summarized as follows:

Environ. Zone	DO (mg/ℓ)	pH	Oil slick	Floating solid wastes	Fecal coliform (MPN/100 mℓ)
SCZ	5	7.0-8.3	nd	nd	nd
CZ	5	7.0-8.3	nd	nd	nd
AMZ	5	7.0-8.3	nd	nd	1,000

Note: 1) nd shows not detectable.
2) Fecal coliform is applied to sea bathing area.

(2) Catchment Area

The Inland Water Quality Standard of Vietnam (TCVN5442, see Table 17.4.1) can be applied to the surface water for all environmental zones.

In terms of effluent standard, the following conservation criteria, which is maximum allowable concentration of pollutants, should be applied to the effluents from industrial plants and other places of business in DZ.

Environ. Zone	Applied Area	BOD (mg/ℓ)	COD_{Mn} (mg/ℓ)	T-N (mg/ℓ)	T-P (mg/ℓ)	SS (mg/ℓ)
DZ	Bai Chay bay catchment	20	30	30	4	50
	Others	50	65	60	6	100

Note: COD_{Mn} was set based on the ratio of COD_{Cr} and COD_{Mn} which was obtained by the Field Survey by the JICA Study team.

As for discharge of treated water from the sewerage system, the following effluent discharge standards were set on the basis of technically possible treatment level.

Environ. Zone	Applied Area	BOD (mg/ℓ)	COD_{Mn} (mg/ℓ)	T-N (mg/ℓ)	T-P (mg/ℓ)	SS (mg/ℓ)
DZ	Bai Chay bay catchment (treatment level 2)	10	15	15	2	15
	Others (treatment level 1)	25	35	-	-	35

Note: 1) Treatment level-1 is a basic secondary treatment.
2) Treatment level-2 is one with nitrification/denitrification and enhanced biological phosphorus removal.

(3) Intermediate Conservation Criteria

The proposed conservation criteria of the seawater are rather more stringent than the existing coastal water quality standards in Vietnam. In order to attain the proposed conservation criteria, building up technical, institutional, and financial capacities of DOSTE and other relating agencies is prerequisite because of their weakness. Thus, it will take a certain time to attain the proposed conservation criteria. Considering required time to build up their capacities, it is reasonable to set intermediate conservation criteria of the seawater quality.

The intermediate conservation criteria were set at the year of 2005. They are set based on the equilibrium of progress of planned projects and possible environmental measures.

Firstly, the projects that will have been completed by 2005 were identified. Next, run-off pollution loads from them were estimated taking the possible environmental measures until then into account. The intermediate conservation criteria were set as a realizable water quality in the bays. It should be noted that the intermediate criteria were not developed in SCZ and CZ, because once the water quality there is deteriorated, it is difficult to retrieve former water quality. Table below summarizes the intermediate conservation criteria set.

Intermediate Water Quality Conservation Criteria (Sea area)

Environ. Zone	Applied area	Transparency (m)	BOD (mg/ℓ)	COD_{Mn} (mg/ℓ)	T-N (mg/ℓ)	T-P (mg/ℓ)	SS (mg/ℓ)
AMZ	Bai Chay coastal	0.5	1.6	9.2	1.8	0.8	17
	Hong Gai coastal	1.0	1.6	9.2	1.8	0.8	6
	Bai Chay bay	1.0	1.6	9.2	1.8	0.8	6
	Cam Pha and Cua Ong	1.0	1.1	5.0	1.6	0.7	8
	Binh Huong estuary	0.5	1.3	7.5	1.6	0.7	15

Note: Since no intensive development project is planned in Binh Huong estuary by 2005, intermediate criteria are same as those of 2010.

17.4.2 Environmental Resources

(1) Natural Environment

Figures 17.4.2 and 17.4.3 show the conservation criteria of forest (green) coverage, tidal flats, and mangrove swamps of each environmental zone. Summarized conservation criteria of natural environment are shown below:

Environ. Zone	Forest (green) coverage	Tidal flats	Mangrove swamps	Coral reefs	Fish and shellfish
SCZ	464km^2 (94%)	1,120ha	200ha	Present conditions	No illegal fishing at fishing grounds
CZ	208km^2 (85%)	-	-	-	ditto
AMZ	-	17,300ha	3,800ha	-	ditto
DZ	228km^2 (52%)	-	-	-	-

Note: Present conditions of coral reefs are distribution, species composition, and living coral reefs.

(2) Landscape

The present condition of landscape of the World Heritage area (SCZ) should be absolutely protected. This requires that the elements producing high value of landscape, such as shape and the surface conditions of islands as well as color and clearness of seawater should be conserved as the present conditions. As for natural scenery, artificial obstacles should be controlled strongly in SCZ. Therefore, the following conservation criteria are proposed on the sea area in SCZ.

Environ. Zone	Shape and surface of islands	Color and clearness of seawater	View of natural resources	Natural scenery
SCZ	No islands changed artificially	To be controlled as water quality	- No islands having bald spots - To be controlled as tidal flats and mangrove swamps	No cargo ships anchored in the World Heritage core area and deviated from the courses

As for the sea areas in CZ and AMZ, landscape there should be controlled as water quality and tidal flats and mangrove swamps management. In terms of inland landscape, it is controlled by green coverage ratio. In DZ, landscape concern should be taken into consideration by development projects and urban designing.

TABLES

Table 17.2.1 Possible Projects by Scenarios

Pollution Sources		Scenario I		Scenario II		Scenario III	
Sources	Location	Projects	SC	Projects	SC	Projects	SC
Domestic	Sewered area	Gien Day WWTP (20,000)	3,4	Gien Day WWTP (76,000)	2,3,4	Gien Day WWTP (106,000)	2,3,4
		Deo Sen WWTP (45,000)	7,8	Deo Sen WWTP (166,000)	6,7,8	Deo Sen WWTP (196,000)	6,7,8
				Cam Pha WWTP (50,000)	10	Cam Pha WWTP (77,000)	6,10
						Ha Tu WWTP (32,000)	6,9
						Cam Phu WWTP (12,000)	11
						Cua Ong WWTP (12,000)	12,13
	Others	no		no		no	
Industry	Existing Factory (sewered area)	treated by sewerage system	3,4,7,8	treated by sewerage system	2,3,4,6,7,8,10	treated by sewerage system	2-4,6-13
	Existing Factory (Others)	no		treated to Effluent Standard B		-	
	New Factory	treated to Effluent Standard B		treated to Effluent Standard A		Scenario II x 70%	
Coal Mining	Wastewater (coal mining areas,	existing treatment system		treated to Effluent Standard B		Scenario II x 50% (SS)	
	coal processing plants, coal ports)					Scenario II x 70% (Other items)	
Livestock	Pigs (sewered area)	50% treated by sewerage system	3,4,7,8	50% treated by sewerage system	2,3,4,6,7,8,10	50% treated by sewerage system	2-4,6-13
	Others	no		no		no	
Non-Specific	Bare land	no		Reforestation (300ha)		Reforestation (1,500ha)	
	Coal mining area	no		Reforestation (1,000ha)		Reforestation (4,300ha)	
	Others	no		no		no	

Notes: 1) SC means sub-catchment, WWTP means Wastewater Treatment Plant.
2) Figures in parenthesis of WWTP mean sewered population.
3) Effluent Standard A, B are from Vietnamese Effluent Standard (TCVN5945-1995)
Standard A: BOD 20mg/ℓ, COD_{Mn} 30mg/ℓ, SS 50mg/ℓ, T-N 30mg/ℓ, T-P 4mg/ℓ (COD_{Mn} was set by the JICA study team)
Standard B: BOD 50mg/ℓ, COD_{Mn} 65mg/ℓ, SS 100mg/ℓ, T-N 60mg/ℓ, T-P 6mg/ℓ (COD_{Mn} was set by the JICA study team)

Table 17.2.2 Runoff Pollution Loads into the Bays in 2010 (Scenario II)

Sub-catch No.	BOD (kg/day)					CODMn (kg/day)					SS (kg/day)					T-N (kg/day)					T-P (kg/day)				
	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total
1	131	1	342	327	800	214	4	468	2,307	2,990	490	6	3,816	27,744	32,100	176	1	504	1,661	2,340	18	0	320	802	1,140
2	66	0	51	37	150	95	0	89	165	350	128	0	471	1,555	2,200	108	0	43	95	250	14	0	25	51	90
3	98	2	36	27	160	144	4	62	115	320	200	14	323	875	1,400	151	1	34	65	250	18	0	20	38	80
4	556	574	168	314	1,910	836	1,206	235	2,166	4,440	1,317	2,179	1,289	24,769	29,600	603	771	320	1,794	3,490	75	116	151	774	1,120
5	41	36	161	189	430	68	69	220	1,301	1,660	155	117	1,198	15,282	16,800	56	34	234	925	1,250	9	3	144	462	620
6	319	3	213	346	880	664	19	299	2,498	3,480	1,090	39	1,638	36,062	38,800	480	5	350	1,832	2,670	62	0	190	835	1,090
7	711	3	83	65	860	1,054	17	138	286	1,500	1,568	23	758	6,455	8,800	953	3	73	195	1,220	116	0	40	92	250
8	333	1	46	45	420	488	3	73	181	740	678	3	404	1,390	2,500	528	0	39	103	670	64	0	20	64	150
9	218	41	314	99	670	331	201	412	419	1,360	567	485	2,248	19,471	22,800	169	51	272	431	920	23	5	171	145	340
10	453	37	55	104	650	679	58	91	500	1,330	1,073	97	513	9,633	11,400	572	31	55	333	990	70	2	29	142	240
11	321	34	42	76	470	247	88	70	330	740	553	142	385	10,247	11,300	162	37	40	248	490	20	3	18	110	150
12	150	236	30	56	470	116	1,293	50	244	1,700	259	10,878	275	6,846	18,300	72	414	24	179	690	10	9	18	80	120
13	144	65	26	29	260	110	122	40	142	410	252	205	230	3,984	4,700	72	115	24	102	310	10	17	9	40	80
14	96	30	110	118	350	110	217	152	870	1,350	252	325	822	21,083	22,500	72	46	216	990	1,320	10	5	117	328	460
15	0	0	0	153	150	0	0	0	1,311	1,310	0	0	0	9,769	9,800	0	0	0	1,100	1,100	0	0	0	479	480
Total	3,640	1,360	1,680	2,010	8,660	5,160	3,300	2,400	12,830	23,680	8,600	14,500	14,400	195,200	233,000	4,170	1,510	2,230	10,050	17,960	520	160	1,270	4,440	6,410

Table 17.2.3 Runoff Pollution Loads into the Bays (Scenario III)

Sub-catch No.	BOD (kg/day)					CODMn (kg/day)					SS (kg/day)					T-N (kg/day)					T-P (kg/day)				
	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total
1	131	0	342	326	800	285	3	468	2,302	3,060	490	4	3,816	26,540	30,900	176	1	504	1,639	2,320	18	0	320	799	1,140
2	33	0	49	37	120	36	0	86	165	290	52	0	453	1,518	2,000	25	0	42	95	160	8	0	24	50	80
3	48	1	34	27	110	111	3	60	115	290	144	10	310	811	1,300	60	1	33	64	160	8	0	19	33	60
4	363	612	162	314	1,450	612	844	228	2,158	3,840	850	1,525	1,251	22,868	26,500	301	540	312	1,752	2,900	48	81	145	769	1,040
5	41	25	161	188	410	90	48	220	1,284	1,640	155	82	1,198	11,521	13,000	56	24	234	853	1,170	9	2	144	453	610
6	256	2	206	344	810	816	13	290	2,465	3,580	1,149	20	1,589	26,882	29,600	433	4	341	1,686	2,460	61	0	183	818	1,060
7	442	2	79	64	590	960	12	133	280	1,380	1,294	16	729	3,819	5,900	453	2	71	171	700	66	0	38	89	190
8	177	1	44	45	270	340	2	70	180	590	460	2	388	1,210	2,100	184	0	37	101	320	27	0	19	63	110
9	15	33	174	97	320	13	141	232	401	790	105	340	1,271	11,103	12,800	53	41	162	343	600	11	4	94	136	240
10	238	26	53	104	420	482	0	88	491	1,060	683	1	498	6,112	7,300	242	0	53	295	590	35	0	28	139	200
11	79	3	26	75	180	169	62	44	319	590	240	100	245	5,356	5,900	79	27	20	203	340	11	2	9	105	130
12	34	167	19	55	270	72	892	31	237	1,230	103	1,113	173	3,946	5,300	31	329	16	152	530	6	7	9	78	100
13	31	52	17	29	130	79	86	26	138	330	96	144	149	2,298	2,700	31	81	16	87	210	6	12	5	39	60
14	96	21	110	115	340	147	152	152	834	1,290	252	227	822	11,181	12,500	72	37	210	782	1,110	10	4	117	307	440
15	0	0	0	183	180	0	0	0	1,311	1,310	0	0	0	9,764	9,800	0	0	0	1,100	1,100	0	0	0	479	480
Total	1,980	950	1,480	2,000	6,400	4,210	2,260	2,130	12,680	21,270	6,100	3,600	12,900	144,900	167,600	2,200	1,090	2,070	9,320	14,670	320	110	1,150	4,360	5,940

Note : Dom. = Domestic, Ind.= Industry, Live.= Livestock, Non-S.= Non-specific sources

Table 17.4.1 Inland Water Quality Standard in Vietnam

No.	Parameter and Substance	Unit	Limitation Values	
			A	B
1	pH	-	6 – 8.5	5.5 – 9
2	BOD_5 (20°C)	mg/ℓ	<4	<25
3	COD	mg/ℓ	<10	<35
4	Dissolved oxygen	mg/ℓ	>=6	>=2
5	Suspended solids	mg/ℓ	20	80
6	Arsenic	mg/ℓ	0.05	0.1
7	Barium	mg/ℓ	1	4
8	Cadmium	mg/ℓ	0.01	0.02
9	Lead	mg/ℓ	0.05	0.1
10	Chromium, Hexavalent	mg/ℓ	0.05	0.05
11	Copper	mg/ℓ	0.1	1
12	Zinc	mg/ℓ	1	2
13	Manganese	mg/ℓ	0.1	0.8
14	Nickel	mg/ℓ	0.1	1
15	Iron	mg/ℓ	1	2
16	Mercury	mg/ℓ	0.001	0.002
17	Tin	mg/ℓ	1	2
18	Ammonia (as N)	mg/ℓ	0.05	1
19	Fluoride	mg/ℓ	1	1.5
20	Nitrate (as N)	mg/ℓ	10	15
21	Nitrite (as N)	mg/ℓ	0.01	0.05
22	Cyanide	mg/ℓ	0.01	0.05
23	Phenol compounds	mg/ℓ	0.001	0.02
24	Oil and grease	mg/ℓ	Not detectable	0.3
25	Detergent	mg/ℓ	0.5	0.5
26	Coliform	MPN/100 mℓ	5,000	10,000
27	Total pesticides (except DDT)	mg/ℓ	0.15	0.15
28	DDT	mg/ℓ	0.01	0.01
29	Gross alpha activity	Bq/ℓ	0.1	0.1
30	Gross beta activity	Bq/ℓ	1.0	1.0

Notes: 1) Values in the column A are applied to the surface water using for source of domestic water supply with appropriate treatments.
2) Values in the column B are applied to the surface water using for the purposes other than domestic water supply.

Source: TCVN 5942, 1995

FIGURES

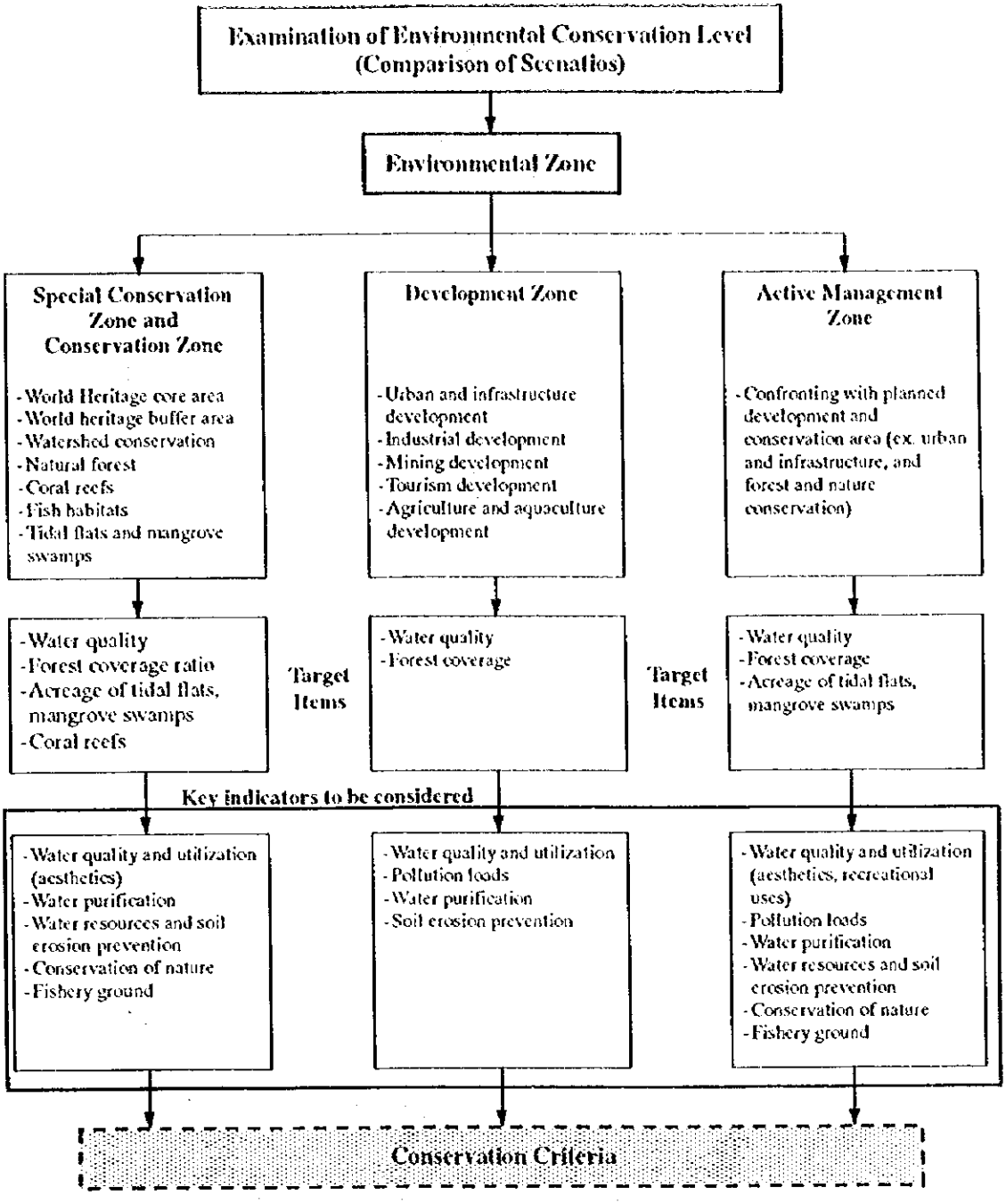


Figure 17.2.1 Schematic Procedure for Setting Conservation Criteria of the Environmental Zone

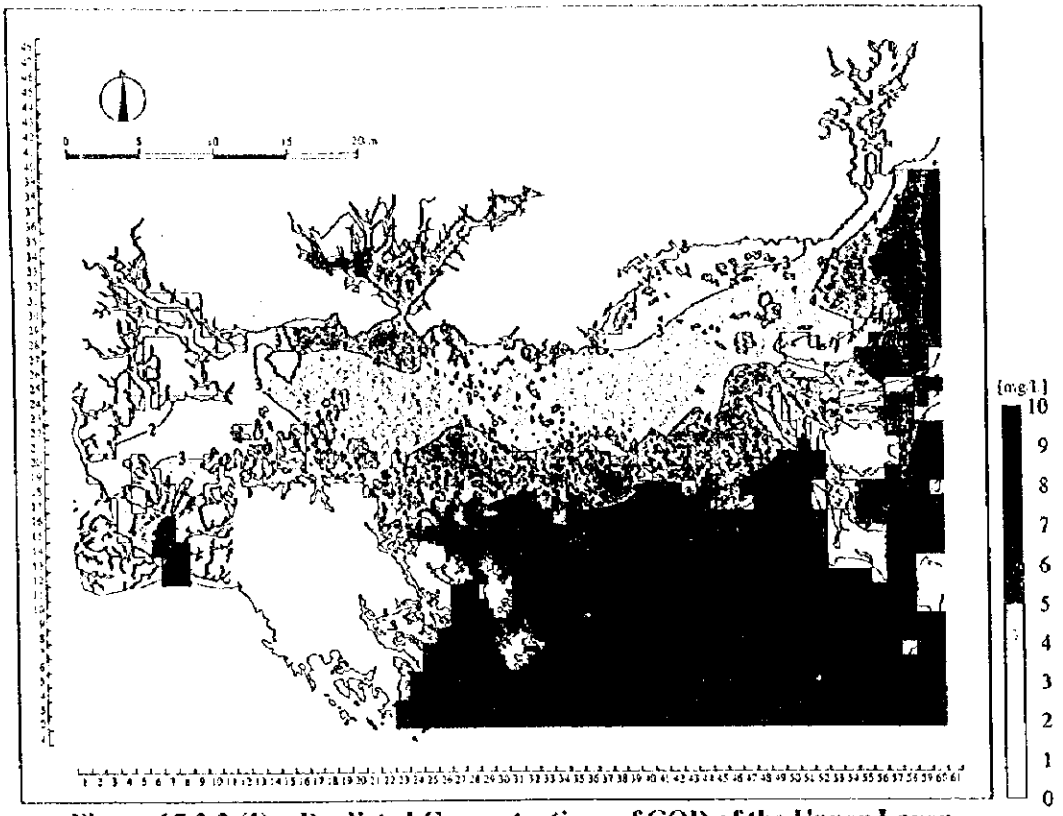


Figure 17.2.2 (1) Predicted Concentrations of COD of the Upper Layer by Scenario II

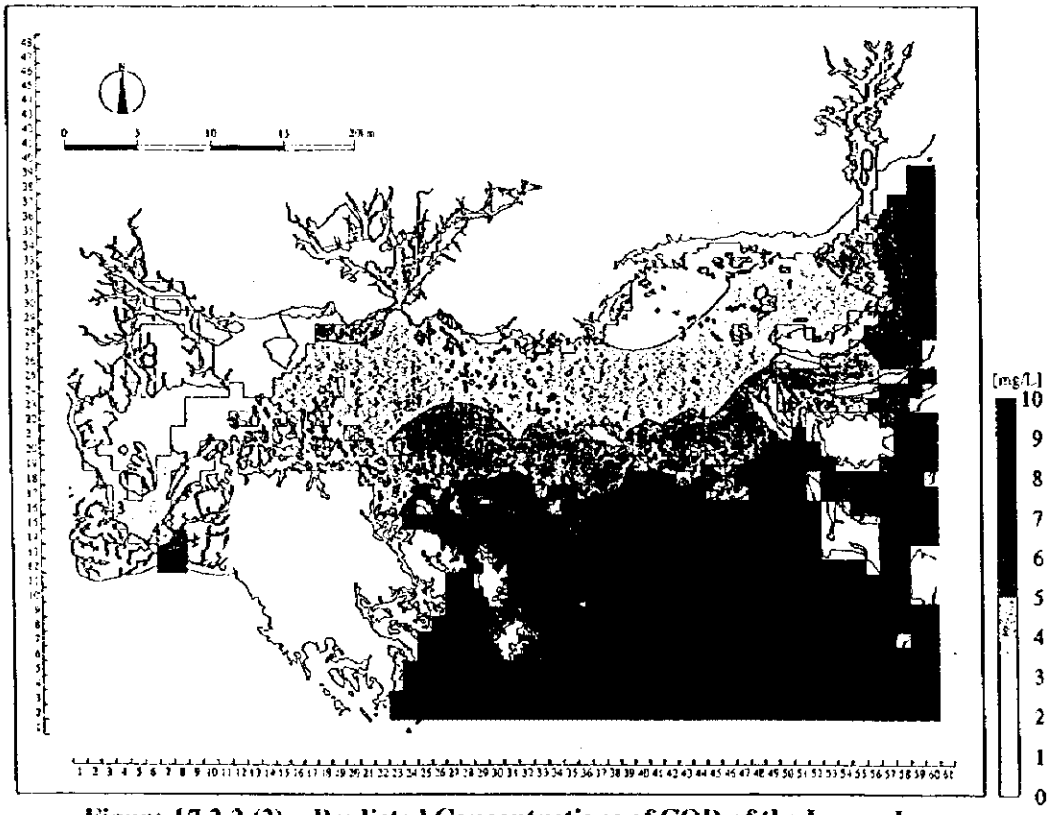


Figure 17.2.2 (2) Predicted Concentrations of COD of the Lower Layer by Scenario II

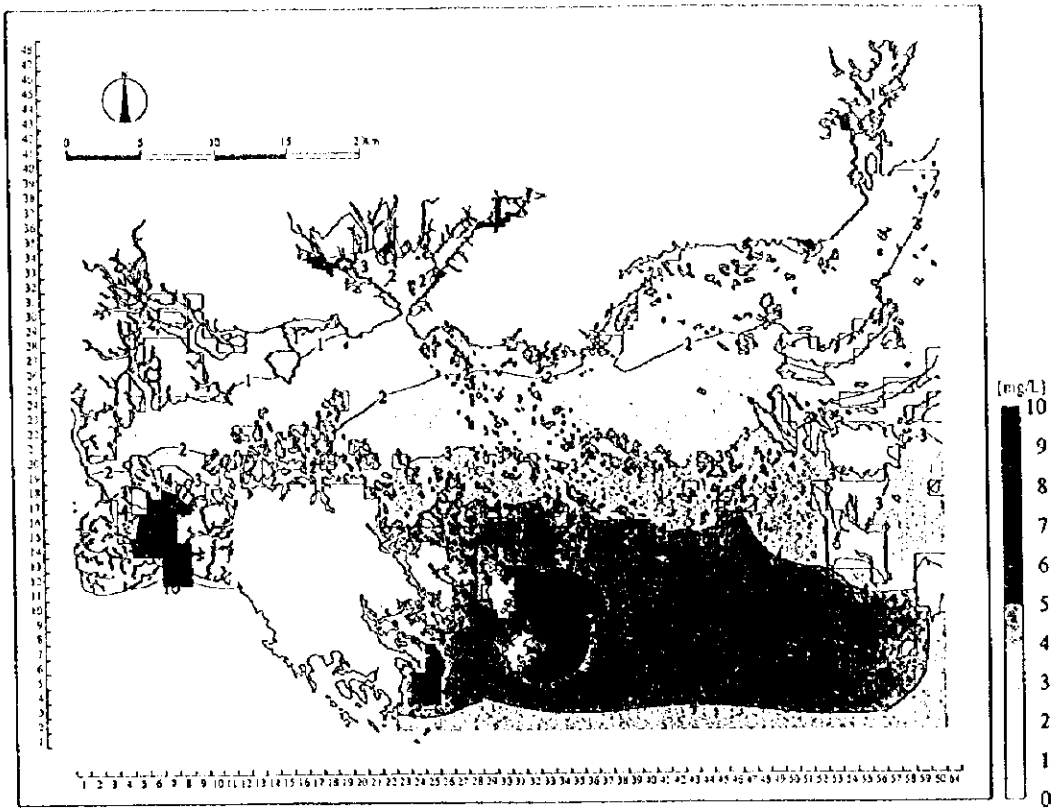


Figure 17.2.3 (1) Predicted Concentrations of SS of the Upper Layer by Scenario II

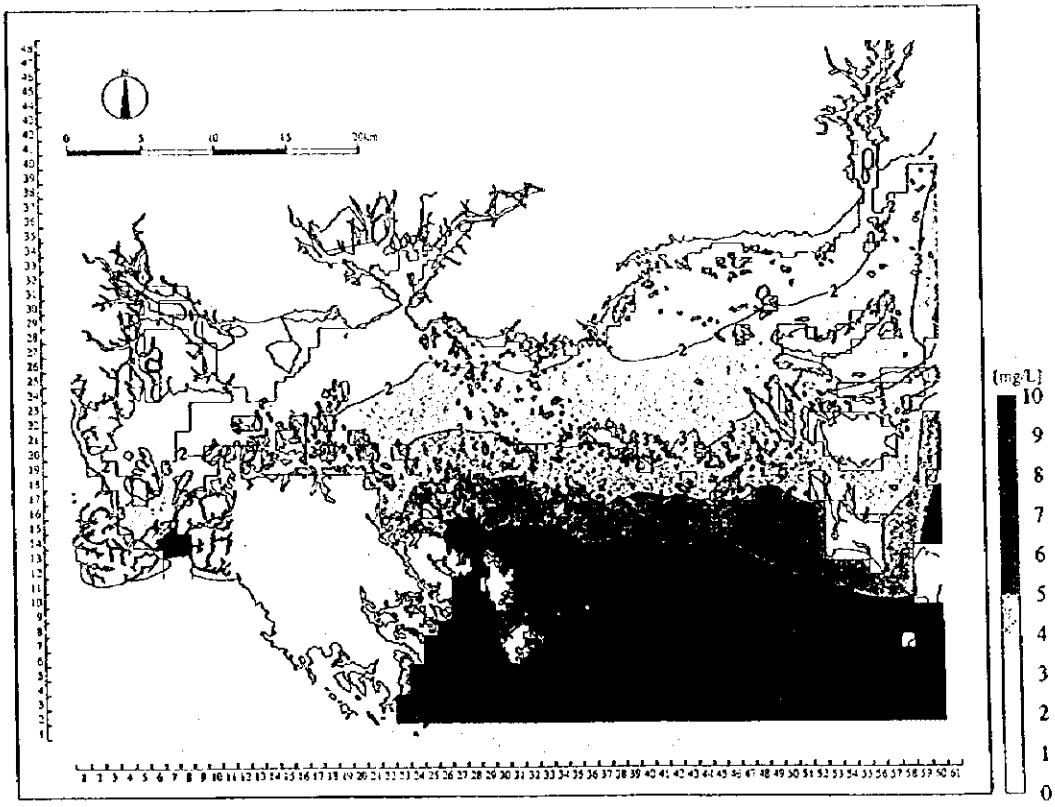


Figure 17.2.3 (2) Predicted Concentrations of SS of the Lower Layer by Scenario II

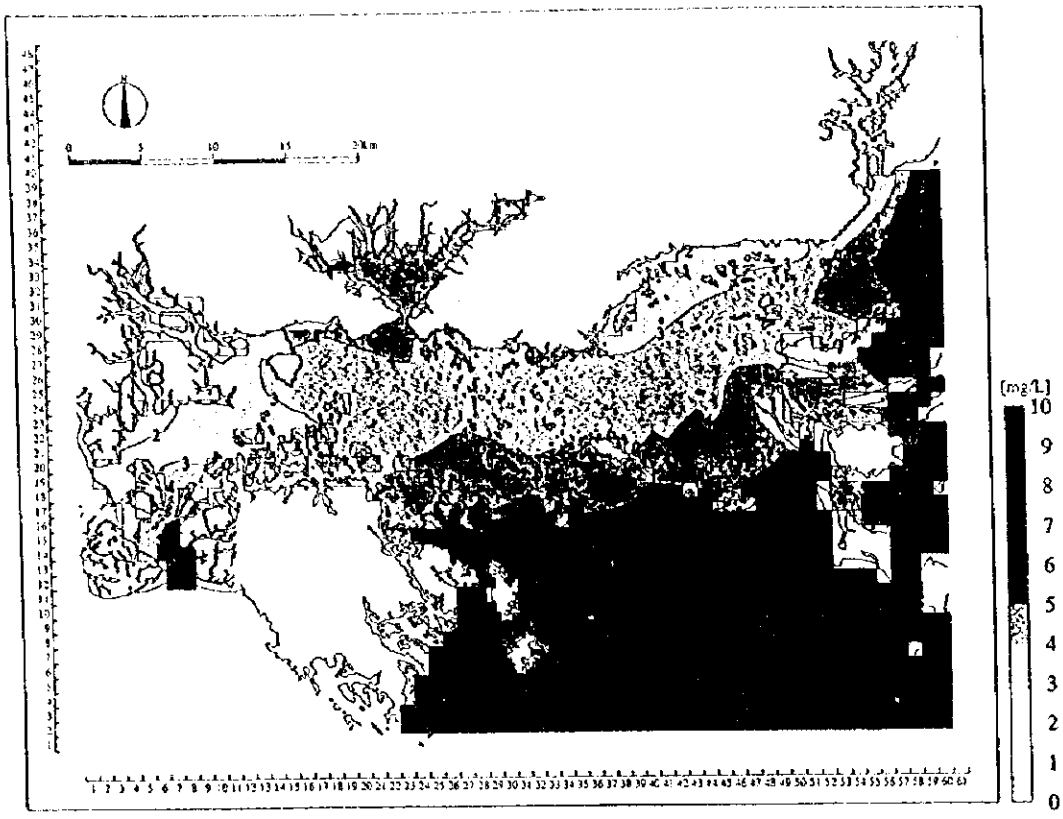


Figure 17.2.4 (1) Predicted Concentrations of COD of the Upper Layer by Scenario III

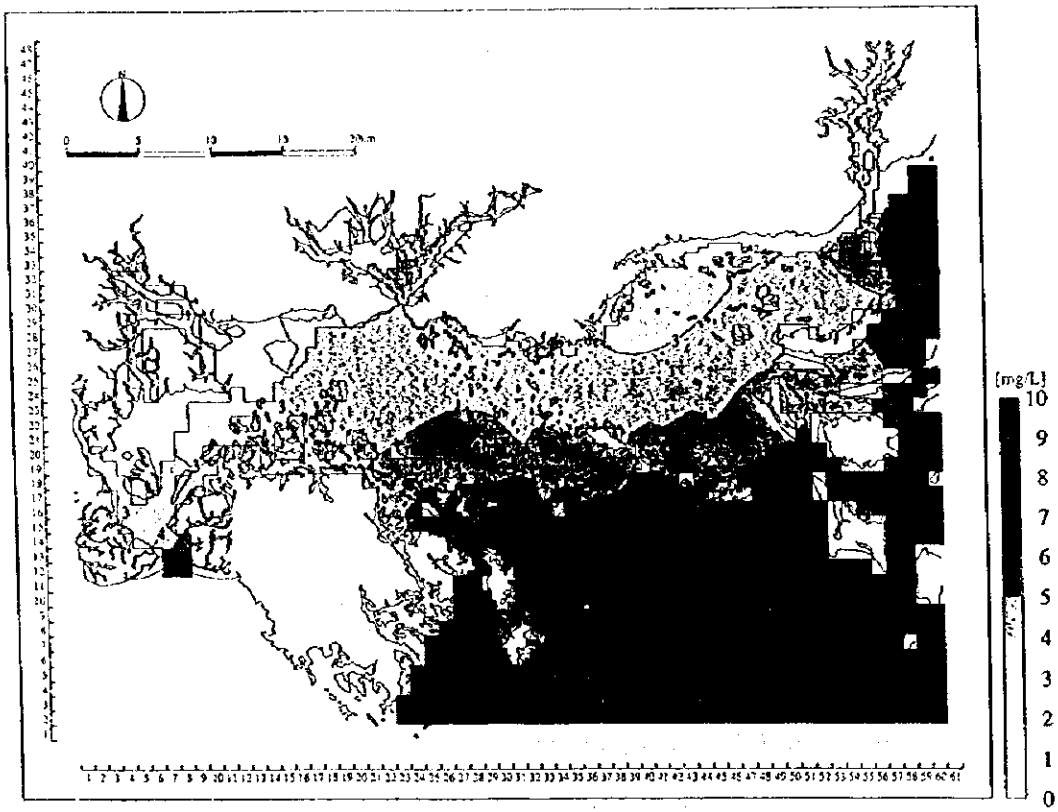


Figure 17.2.4 (2) Predicted Concentrations of COD of the Lower Layer by Scenario III

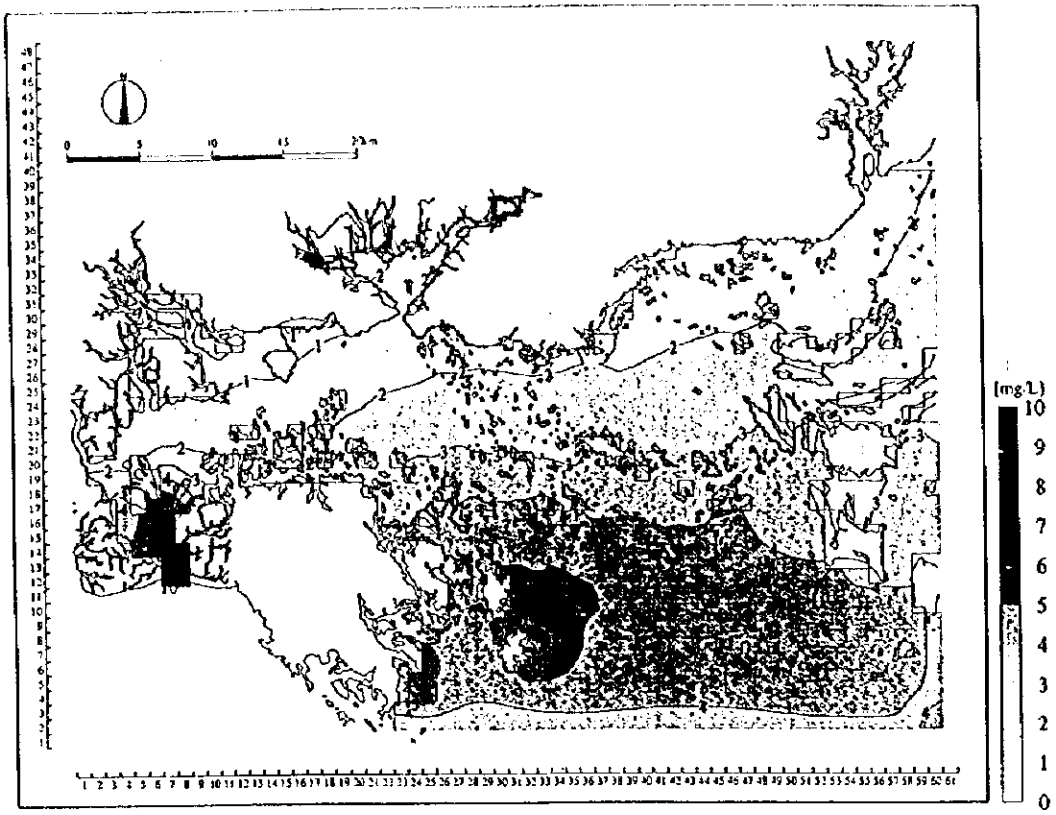


Figure 17.2.5 (1) Predicted Concentrations of SS of the Upper Layer by Scenario III

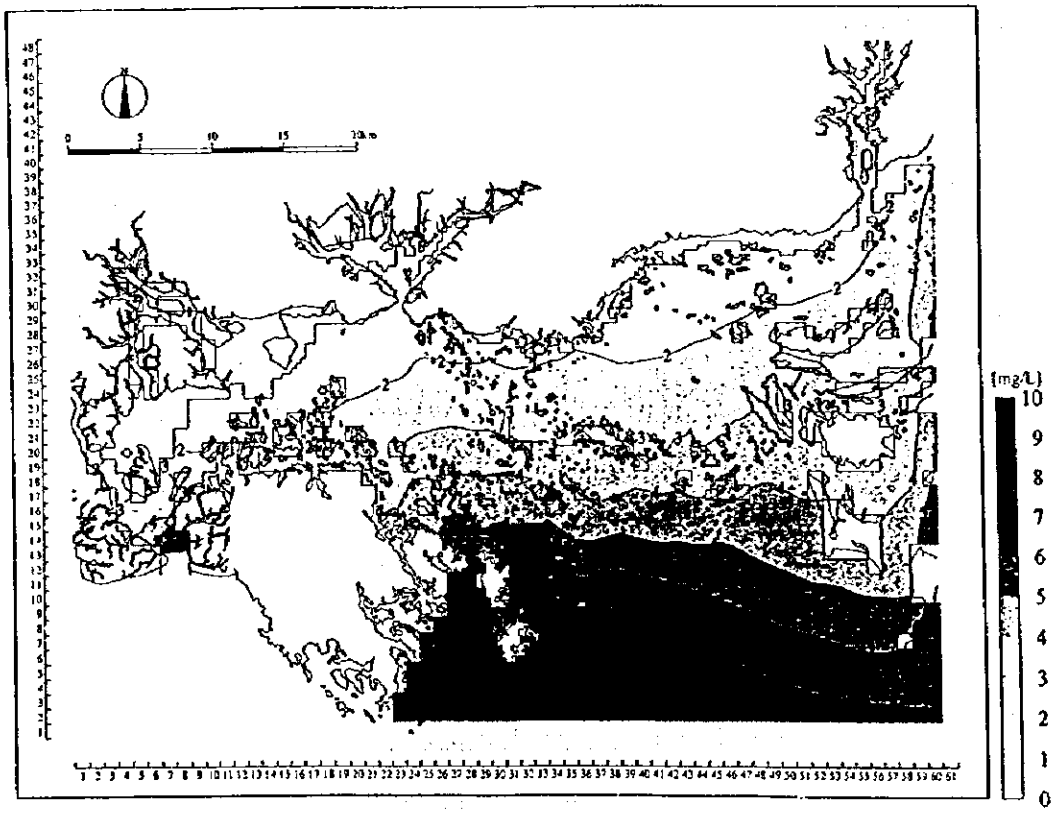


Figure 17.2.5 (2) Predicted Concentrations of SS of the Lower Layer by Scenario III

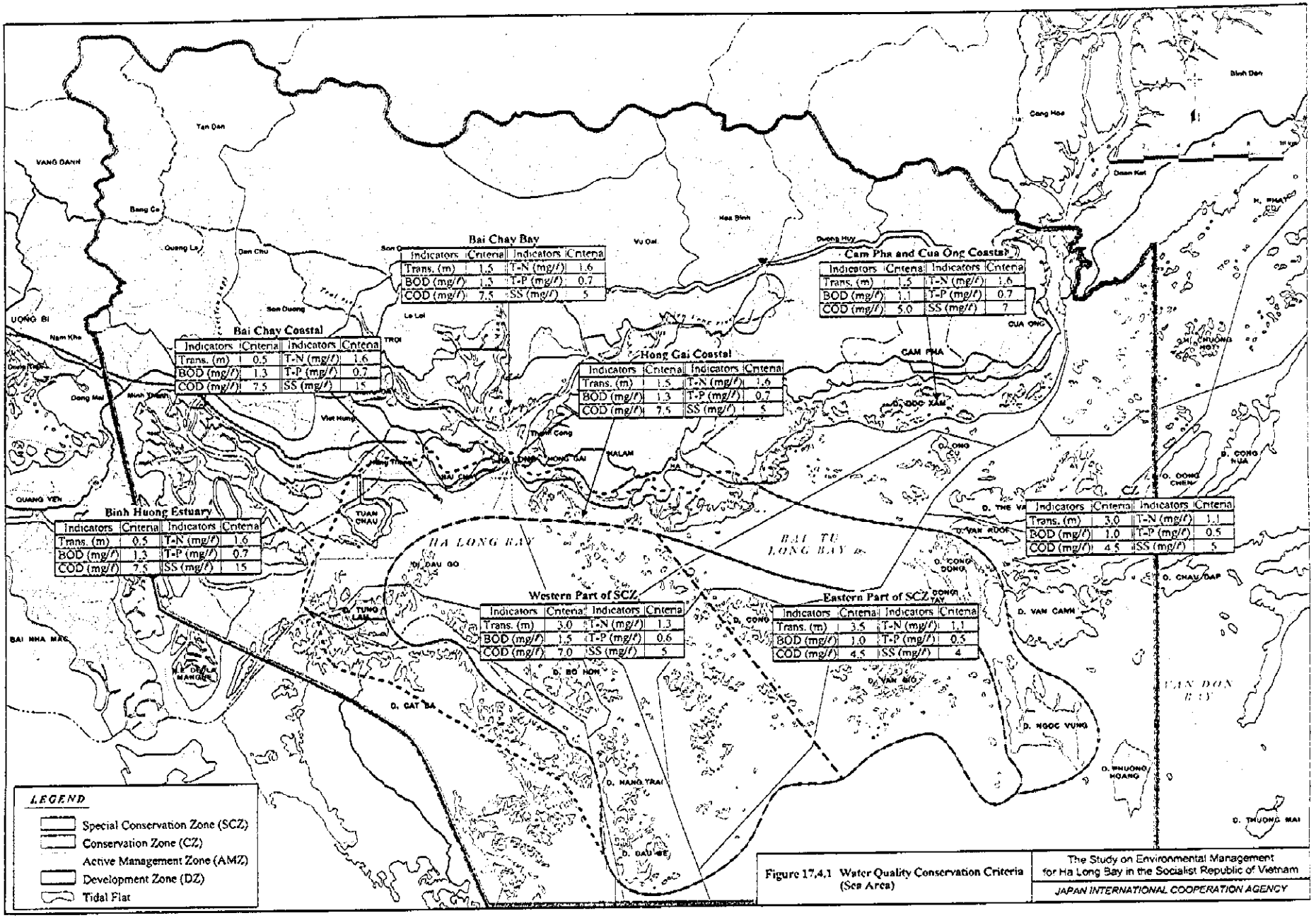


Figure 17.4.1 Water Quality Conservation Criteria (Sea Area)

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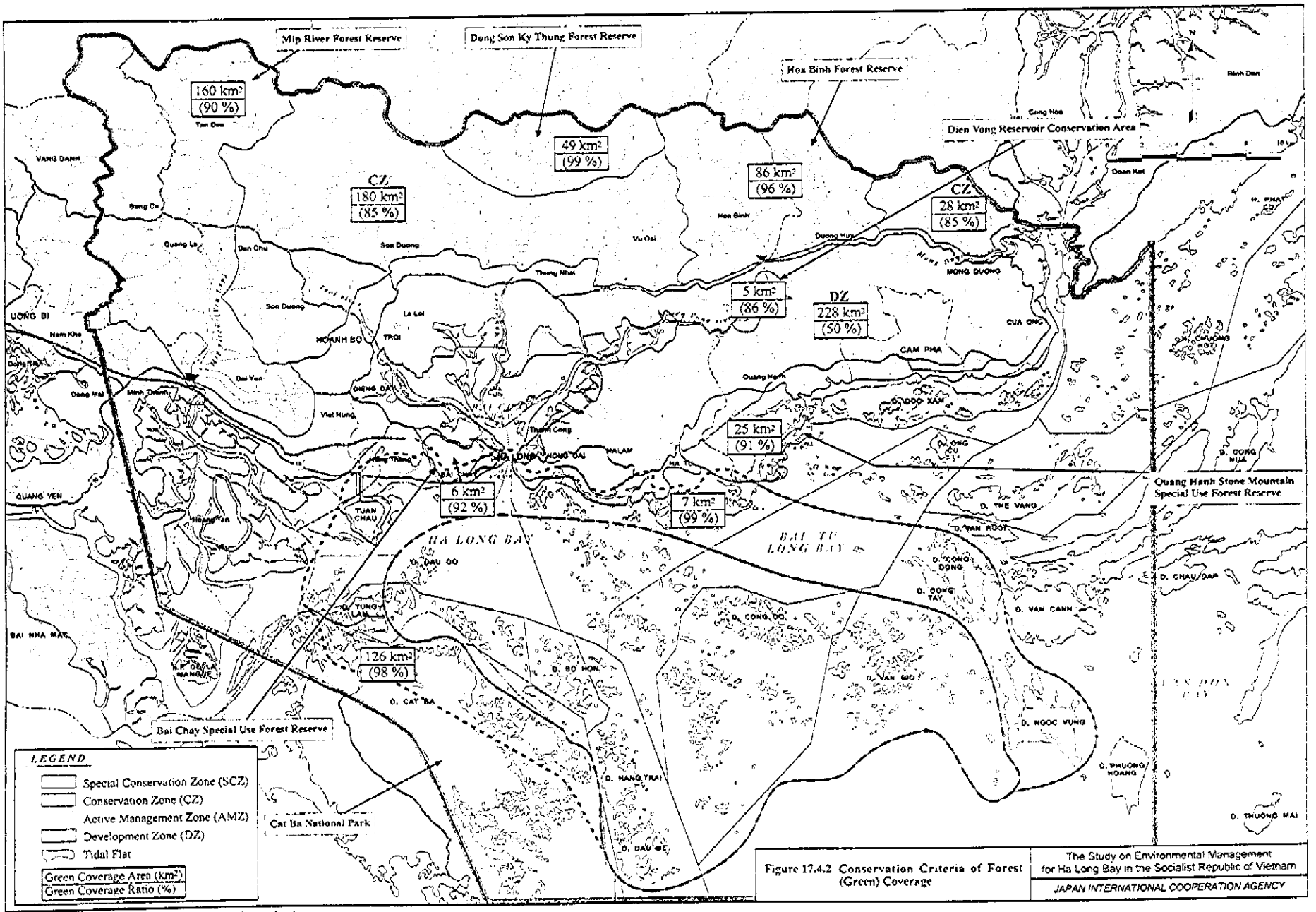

Figure 17.4.2 Conservation Criteria of Forest (Green) Coverage

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Note: Green cover consists of forest, scrub and grass lands

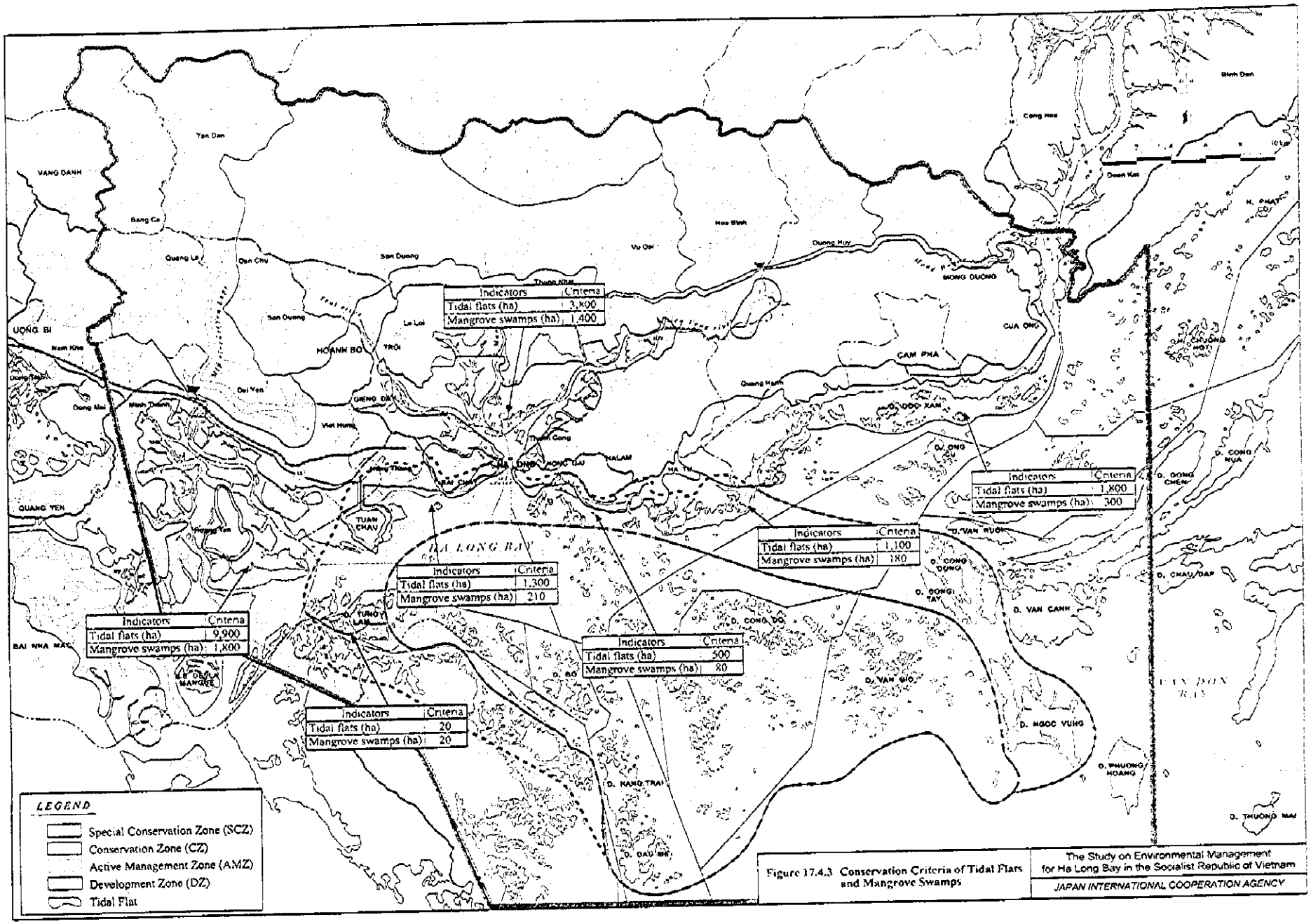

Figure 17.4.3 Conservation Criteria of Tidal Flats and Mangrove Swamps

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CHAPTER 18

CHAPTER 18 ENVIRONMENTAL MEASURES TO ATTAIN CRITERIA

18.1 Basic Concept of Environmental Measures

18.1.1 Management Method of Each Target

(1) Management Method of Water Quality

1) Basic strategy of pollution loads control

To achieve the conservation criteria of water quality, total pollution load control is required in addition to the concentration control. The sea area in the EMP area was divided into three environmental zones; Special Conservation Zone (SCZ), Conservation Zone (CZ), and Active Management Zone (AMZ). Among them, AMZ is located along the coastal line of the hinterland where most of the future development activities are planed. Thus, the pollution loads flowing into AMZ should be controlled firstly, to control total pollution loads flowing into the bays.

To achieve the conservation criteria of AMZ is prerequisite to achieve those of CZ and SCZ. Basic strategy of pollution loads control is show below.

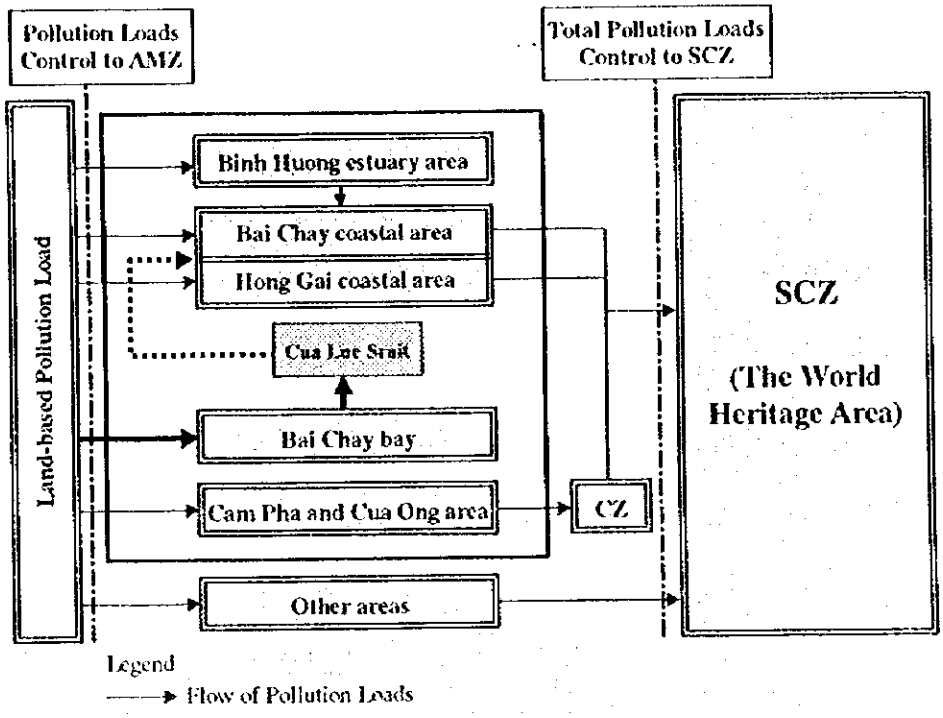

Figure 18.1.1 Basic Strategy of Pollution Loads Control

2) Allowable pollution load

In order to achieve the conservation criteria of AMZ, allowable runoff pollution loads flowing into each area in AMZ were calculated by mass balance analysis. Allowable runoff pollution loads are summarized below:

Allowable Pollution Load

Enviro. Zone	Applied area	BOD (kg/day)	T-N (kg/day)	T-P (kg/day)	SS (kg/day)
AMZ	Bai Chay coastal area	170	240	100	2,300
	Hong Gai coastal area	420	670	150	2,500
	Cam Pha and Cua Ong area	1,550	3,100	820	56,800
	Bai Chay bay area	3,300	7,200	2,900	93,000
	Binh Huong estuary area	950	2,500	1,200	37,800

3) Management method

For the water quality management especially pollution loads control, wastewater control for specific pollution sources is required in the first place. This is because that effects of measures for specific sources are clear and quick works. Most management measures for specific pollution sources are sewerage system and/or individual wastewater treatment system such as industrial wastewater treatment. Most livestock are being raised in agricultural land and/or near markets and farmers houses. It is assumed that the wastewater of livestock will be treated by sewerage system together with domestic or market wastewater if it is in a sewered area.

In addition to this, measures for nonspecific pollution sources such as greening are required especially for control of SS. To control runoff SS from coal mining areas, the conservation criterion for the mining area was set based on the size of denuded area.

(3) Management Method of Environmental Resources

1) Management method of natural environment

In order to manage environmental resources, implementation of monitoring and inspection are required. Hardware type measures such as reforestation, or revegetation of denuded areas, and rehabilitation of mangrove swamps are also required as mitigation to compensate for the lost environment. In addition to this,

indispensable software type measures such as land use and land reclamation controls and enforcement of regulation should be taken into consideration.

Since responsible organizations for the coal mining areas and other areas are different, it is recommended that reforestation or revegetation of denuded areas in and outside of coal mining areas be carried out by each responsible organization. VINACOAL has a responsibility of management of coal mining areas, while the Forest Protection Agency (FPA) and the Department of Agriculture on Rural Development (DARD) have responsibilities of forest management excluding coal mining areas.

2) Management method of landscape

To achieve the conservation criteria on landscape, preparation of landscape management guideline, and enforcement of patrol and inspection capability will be required.

18.1.2 Required Measures by Environmental Zones

In the EMP area, most of human origin pollution loads are generated in DZ. Lots of development projects and socioeconomic growth together with increase in population are planned there in the future. Therefore, to control total pollution loads from them into the bays, sewerage system and/or individual wastewater treatment system are required in DZ before the generated pollution load flowing into the bays through AMZ. Similarly, rehabilitation of coal mining areas as well as treatment of mine wastewater is also required mainly in DZ.

Domestic and industrial solid wastes management is also required mainly in DZ. The collection of floating solid wastes, however, should be carried out in SCZ, CZ, and AMZ.

Measures for tourism and landscape are mainly required in SCZ to improve sanitation conditions there, and keep attractive and beautiful landscape. In case of natural environment, its management measures should be implemented based on the distribution of each resource, for example measure for tidal flats and mangrove

swamps are should be developed in AMZ, and those for fish and shellfish are in SCZ and CZ, while reforestation is necessary for the whole catchment area.

The required measures by environment zones are summarized below.

Required Measures by Environmental Zones

Environ. Zones	Conservation Criteria	Necessary Actions	Required Measures
SC	1) Water quality - Trans.: 3.0~3.5m - BOD: 1.0~1.5 mg/ℓ - COD: 4.5~7.0 mg/ℓ - T-N: 1.1~1.3 mg/ℓ - T-P: 0.5~0.6 mg/ℓ - SS: 4~5 mg/ℓ 2) Environmental resources - Forest coverage : 464 km^2 - Tidal flats: 1,120 ha - Mangrove swamps: 200 ha - Coral reefs: present condition - Fish and shellfish: no illegal fishing - Landscape: no island changed artificially, no islands having bald spot, no cargo ship anchored in the Word Heritage area	1) Keeping attractive and beautiful landscape - Water quality control - Solid wastes control - Landscape element management 2) Conservation of natural environment (forest, tidal flats, mangrove swamps, coral reefs) 3) Sustainable use of fishing ground	1) Sea area - Improvement of sanitation condition (management of wastewater and solid wastes of islands and tourist boats) - Reinforcement of patrolling capability - Fishing activity control - Measures for landscape 2) Catchment area - Forest reserve area
CZ	1) Water quality - Trans.: 3.0m - BOD: 1.0 mg/ℓ - COD: 4.5 mg/ℓ - T-N: 1.1 mg/ℓ - T-P: 0.5 mg/ℓ - SS: 5 mg/ℓ 2) Environmental resources - Forest coverage : 208 km^2 - Fish and shellfish: no illegal fishing	1) Keeping good water quality - Water quality control - Solid wastes control 2) Conservation of natural environment (forest) - Forest protection - Reforestation 3) Sustainable use of fishing ground	1) Sea area - Water quality: to be controlled in AMZ and DZ - Fishing activity control 2) Catchment area - Reforestation in bare areas

Environ. Zones	Conservation Criteria	Necessary Actions	Required Measures
AMZ	1) Water quality - Trans.: 0.5~1.5m - BOD: 1.1~1.3 mg/ℓ - COD: 5.0~7.5 mg/ℓ - T-N: 1.6 mg/ℓ - T-P: 0.7 mg/ℓ - SS: 5~15 mg/ℓ 2) Environmental resources - Tidal flats: 17,300 ha - Mangrove swamps: 3,800 ha - Fish and shellfish: No illegal fishing	1) Water quality control aimed at control in SC and CZ - Protection of decrease in tidal flats coverage - Upgrading of mangrove swamps 2) Conservation of natural environment 3) Sustainable use of fishing ground	- Water quality: keeping a water purification capacity - Reclamation control at tidal flats - Rehabilitation of mangrove swamps - Fishing activity control
DZ	1) Water quality - TCVN (5942) 2) Environmental resources - Forest coverage: 228 km^2	1) Total pollution loads control flowing into AMZ - Wastewater treatment - Solid wastes management - Reforestation 2) Upgrading forest coverage - Reforestation 3) Preventive measures for soil erosion - Reforestation	1) Development of sewerage system - Drainage system - WWTP 2) Development of industrial WWTP 3) Solid wastes management - Collection vehicles and equipment - Landfill sites - Incineration of clinical and hazardous wastes 4) Measures for mining - Mine wastewater treatment - Measures for coal processing plants - Rehabilitation of dumping sites and river basins - Dredging 5) Measures environ. resources - Reforestation in bare areas

Note: Trans. means transparency.

With regard to measures in rural areas and/or in the upper stream areas in the catchment of the bays, the present progress of the measures such as installation of a septic tank for domestic wastewater treatment are enough to attain the conservation criteria due to the relatively small runoff pollution loads from these areas into the bays. It should be noted, however, that the forest reserve areas should be managed strictly, so illegal deforestation activities there should be prohibited.