

Chapter 3 Assessment of the Future Environmental Conditions without Counter-measures

3.1 Predicted Water-Related Sanitation Environment in the Future without Counter-measures

As mentioned in Section 1.2, the urban area is seriously affected by flooding, which causes various kinds of damage to the socioeconomic life of the residents.

Direct damage to houses, household goods, shops, merchandise, public/government buildings, factories, farms, and fisheries is identified in the report of the Study on Urban Drainage and Wastewater Disposal System in Hanoi City prepared by JICA in 1995. Indirect damage is also taken into account, including damage to transportation, communication, industry, and business.

In light of the above, this section describes the flood frequencies including inundation periods and water levels that are predicted for the future if counter-measures are not taken.

Natural drainage from the To Lich River basin to the Nhue River is totally inadequate for large-scale floods, but not for small-scale floods. The maximum discharge from To Lich to Nhue should, even during small-scale floods, be limited to $0.6 \text{ m}^3/\text{s}/\text{km}^2$. This is judged by MOARD to be adequate for keeping the protection level at a 10-year return period to the Nhue River. For the Nhue River basin, on the other hand, discharge must always be confined to less than $0.6 \text{ m}^3/\text{s}/\text{km}^2$, whether natural or mechanical drainage methods are applied.

During flood periods in the urban area, it is nearly impossible to drain storm-water in the urban area by gravity to the Nhue River since the Than Liet floodgate located in the downstream stretch of the To Lich River is closed at a water level of EL.3.5m. The water level of the Nhue River rapidly rises above EL.5.0m in case of intensive heavy rainfall and remains higher than EL.3.5m for over 10 days. This causes the water level to rise in the city rivers, flooding the urban area as shown in Figure 1.2.5 of Part 2.

Flood probability of the city rivers is summarized as follows:

Flood Probability	
Drainage Systems	Flood Probabilities (Without measures)
To Lich River	3-year to 5-year
Lu River	1.2-year
Kim Nguu River	1.6-year
Set River	1.1-year
Overall To Lich River System	1.2-year
Nhue River System	Less than 5-year
Red River System	More than 100-year
Flood plain area	10-year to 25-year
Other Main Rivers	5-year to 10-year
Channels	0.5-year to 5-year
Sewers	Less than 1-year

The urban area has suffered from floods every year, since flood probability of urban drainage facilities, such as drainage channels and sewers, is less than 1.0-year due to the lack of flow capacity. Figure 3.1.1 shows the flooding condition of roads in the urban area classified by rainfall per hour (mm/hr), on the assumption that the concentration time of the main sewer is 60 minutes.

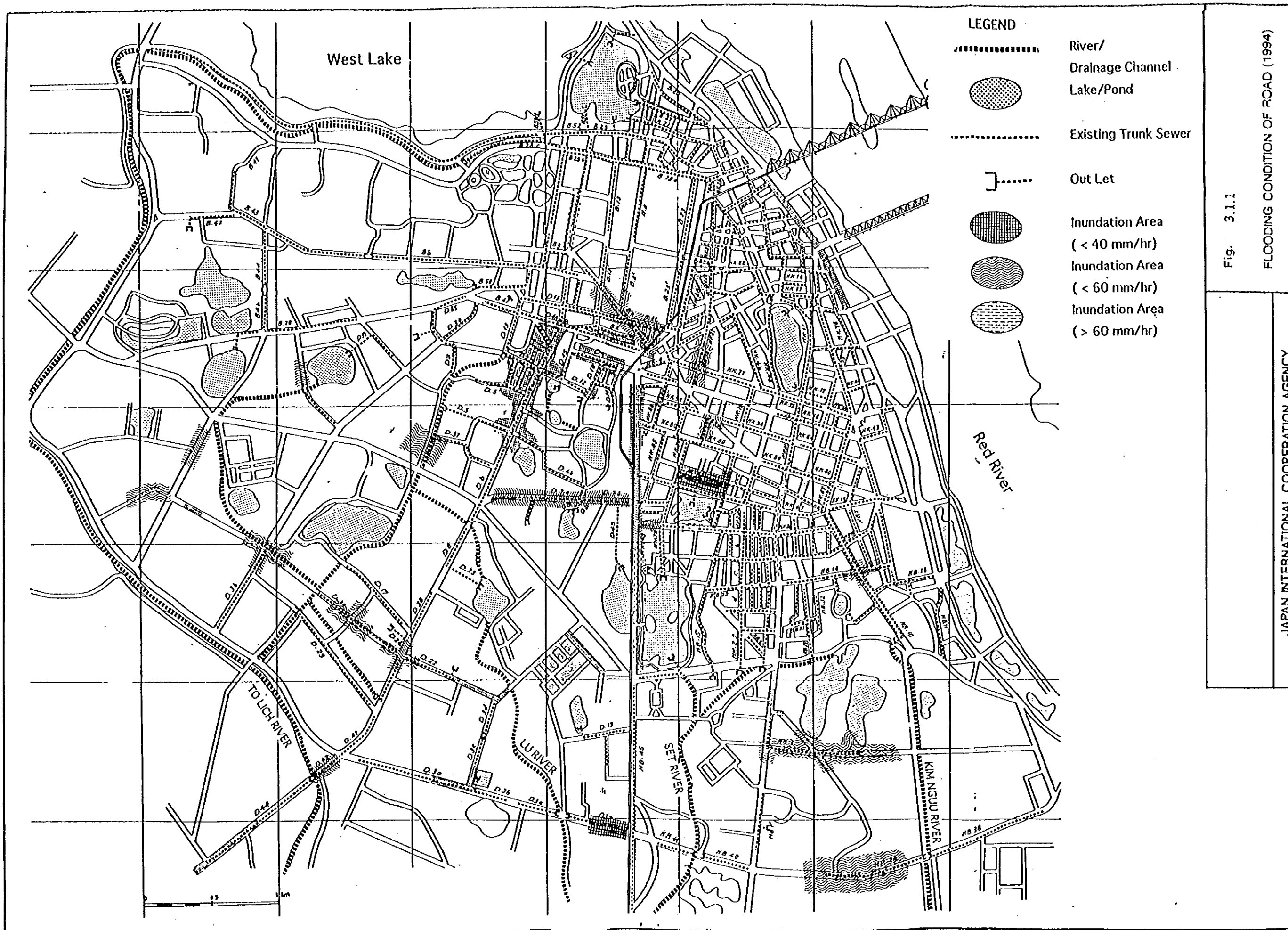


Fig. 3.1.1

FLOODING CONDITION OF ROAD (1994)

JAPAN INTERNATIONAL COOPERATION AGENCY

3.2 Expected Water Quality in the Future without Counter-Measures

This section presents estimates of future water pollution in 2010 and 2020 without any counter-measures.

3.2.1 Estimation of the Pollution Load Generated

(1) Pollution Source

1) Domestic Pollution Load

Among of domestic wastewater generated and pollution load are estimated by using the same formula as shown in section 1.3.4(2), using data concerning the estimated unit wastewater generation amount, unit BOD pollution load, and predicted population.

Unit BOD pollution load and unit water consumption were estimated in the Hanoi Drainage JICA Study (1995) and Hanoi Water Master Plan JICA Study (1997) as shown below.

Unit Pollution Load and Unit Water Consumption
Assumed in Previous JICA Study in Hanoi

Year	Unit Pollution Load*1	Unit Water Consumption*1		Unit Water Consumption*2		
		Public Water	Individual Water	U*	D*	R*
1992	40g/p/day	90	50			
1996				120	70	50
2000				150	105	60
2005				165	135	75
2010	60g/p/day	180	100	180	165	90

Data Source *1: Hanoi Drainage JICA Study (1995)

*2: Hanoi Water Master Plan JICA Study (1997)

Note *U: urban area, D: development area, R: rural area

As family incomes increase, unit BOD pollution load per capita will increase gradually up to a certain level and then remain at that level. In the Study, it is assumed that the level of unit BOD pollution load per capita will increase to 60 g/p/day in 2010, and then maintain this level until 2020. The ceiling level is almost the same as in Japan. On the other hand, unit water consumption is assumed to increase gradually until 2020. Based upon results of the previous studies, unit BOD pollution load and wastewater generation per capita are assumed in the Study as shown below.

Base Data in the Study

Year	Unit Pollution Load (BOD g/p/day)	Wastewater Generation (L/p/day)	
		Urban Area	Rural Area
1997	40	120	50
2005	50	160	80
2010	60	180	90
2020	60	200	100

It was assumed that all water consumed is subsequently discharged as wastewater.

2) Commercial and Institutional Pollution Load

It is assumed that commercial and institutional pollution load and wastewater generation of commercial and institutional wastewater are 30% of the case of domestic pollution wastewater, as described in section 1.3.4.

3) Industrial Pollution Load

At present, industrial zones occupy about 440 ha. Industrial zones and estates are planned to expand to 1,240 ha in 2005, 1680 ha in 2010, and 2540 ha in 2020.

Planned industrial estates are expected to prepare central wastewater treatment facilities. According to the Vietnamese Industrial Effluent Standard, the required level of treatment process will be BOD 20 mg/L. However, for the purpose of estimation for the worst case scenario, construction of central treatment processes in new industrial zones are omitted here. This means that unit pollution loads and wastewater generation rates in future years are assumed to be the same as at present.

Industrial development plans for each environmental zone are shown in Table 3.2.1

(2) Estimation of of Pollution Loads

Based on this data, BOD pollution loads generated in each environmental zone are calculated as below.

BOD Pollution Load Generated in each Environmental Zone

	Basin Area (ha)	1997	2010	2020 (kg/day)
Zone 1 Old City Center	3,499	47,946	59,082	62,400
Zone 2 Red River Right Bank – North West	5,590	14,391	26,920	35,746
Zone 3 Red River Right Bank – South	2,695	17,062	21,574	26,118
Zone 4 Dong Anh Urban Area	8,525	7,044	30,479	66,736
Zone 5 Gia Lam Urban Area	4,295	9,272	15,932	33,744
Zone 6 Suburban Area	62,988	40,753	66,394	80,218
Zone 7 Ho Tay Area	410	1,067	1,986	2,496
Total Study Area	88,002	137,535	222,366	307,458

For the purpose of comparison with each environmental zone, unit BOD pollution load generation per area is also calculated as shown below.

Unit BOD Pollution Load Generated in each Environmental Zone

	Basin Area (ha)	1997	2010	2020 (kg/ha/day)
Zone 1 Old City Center	3,499	13.70	16.89	17.83
Zone 2 Red River Right Bank – North West	5,590	2.57	4.82	6.39
Zone 3 Red River Right Bank – South	2,695	6.33	8.01	9.69
Zone 4 Dong Anh Urban Area	8,525	0.83	3.58	7.83
Zone 5 Gia Lam Urban Area	4,295	2.16	3.71	7.86
Zone 6 Suburban Area	62,988	0.65	1.05	1.27
Zone 7 Ho Tay Area	410	2.60	4.83	6.09
Total Study Area	88,002	1.56	2.53	3.49

Based on these calculations, the following conclusions can be reached:.

- The population in the Study Area is expected to increase rapidly from 2.47 million in 1997 to 3.51 million in 2020, and living standards are also expected to become higher. Accordingly, total BOD Pollution load in the Study Area is estimated at 136,564 kg/day in 1997, 226,409 kg/day in 2010 and 309,421 kg/day in 2020.

- Regarding the area with the greatest pollution, i.e., Environmental Zone 1 (the Old City Center), the population is expected to decrease from 922,000 in 1997 to 800,000 in 2020 due to the restriction of the development. However, the increase in unit BOD load generation will make the BOD Pollution Load in Environmental Zone 1 increase from 47,946 kg/day in 1997 to 62,400 kg/day in 2020. Zone 1 with 3,499 ha, which is 4% of the area of Hanoi City generates 35% of the total pollution load in 1997 and will generate 20 % in 2020. Because of the high increase in pollution load generation in other areas, especially Gia Lam and Dong Anh, the proportion of pollution generated in Zone 1 will become relatively low. Nevertheless, unit BOD generation per ha in the area is extremely high, compared with other areas.
- Due to drastic development described in the Master Plan, unit BOD pollution generation in Zone 4 Dong Anh Urban Area and Zone 5 Gia Lam Urban Area are expected to increase rapidly, i.e. more than 9 times and 3 times, respectively, from 1997 to 2020. The water environment in these areas is therefore expected to be changed drastically.
- Domestic pollution load accounts for 72% of total pollution load in 1997, and is predicted to be 68% in 2010, 68% in 2020. Industrial pollution load accounts for 6% in 1997, rising to 11% in 2010, 12% in 2020. The rate of Industrial pollution load in Gia Lam and Dong Anh Urban Area is relatively high. The rates in Gia Lam and Dong Anh Urban Area in 2020 will be 21% and 27%. 35% of the industrial zones will be located in Dong Anh Urban Area, and 20% is to be located in Gia Lam Urban Area. Treatment of industrial effluent in these areas is very important part of the pollution countermeasures in the area.

3.2.2 Assessment of the Receiving Water Quality

To predict the quality of water bodies, the runoff pollution load must be estimated. Runoff pollution load depends on pollution load generation and land use. Land use in new development areas is expected to change considerably. In the case of Dong Anh Urban Area and Gia Lam Urban Area, the existing agriculture land which is about 50% of the total area is expected to disappear, and change to urban use including housing and industrial development. Because of the lack of data and time, it is assumed the runoff of pollution is the same in this area as in the Study Area. The water pollution runoff model described in section 1.3.4 (4) is used to estimate future water pollution.

(1) Major Rivers

The method of predicting the water quality of the major rivers is described in section 1.3.4.

1) Cau River

The basin of Cau River in the Study Area is 54,400 ha, which consists of Dong Anh and Soc Son district and part of Gia Lam district. For the prediction, BOD pollution load, wastewater generation and river flow amount are estimated as shown below.

According to the river flow record, yearly average flow of Cu River is recorded between 180 m³/day and 270 m³/day between 1965 and 1973. Half of the minimum yearly average flow, 90 m³/day (15,552,000 m³/day) is adopted as Cau River Flow for the calculation. The results of the prediction is as shown below.

Prediction of BOD Concentration in Cau River

		1997	2010	2020
BOD Pollution Load	kg/d	31,215	76,700	121,577
Wastewater Generation	m ³ /d	51,743	167,267	309,865
River Flow	m ³ /d	4,752,000	4,752,000	4,752,000
Incremental BOD concentration from 1997	mg/L	0	+1.9	+3.6
Expected BOD concentration	mg/L	2.8 – 3.2*	4.7 – 5.1	6.4 – 6.8
Evaluation		U	U	U

Note: U: unpolluted, SP: slightly polluted, P: polluted

BOD values measured under the Study in 1999.

Even if no countermeasures are taken, water quality in Cau River will still be clean because of the large amount of river flow with unpolluted water quality. Outside of the Study Area, industrial activities in Bac Can, Thai Nguyen, Bac Ninh, Hai Duong, Bac Giang and Vinh Phuc District may have some impact on Cau River downstream of the Study Area.

2) Ca Lo River

The basin of Ca Lo River in the Study Area is about 32,600 ha, which consists of Dong Anh and Soc Son district. Due to the drastic urban development expected in Dong Anh urban area, the drainage system should be changed. At present, the area of agricultural land, especially paddy field, accounts for about the half of the area in Donh Anh. Therefore, the

drainage system and irrigation system are combined, and large part of wastewater generated in the area is consumed in agriculture land. It is assumed for the future prediction that all water in the area is discharged to Ca Lo River because of the dyke along Red River. However, some of the area would be drained to Red River by the new drainage system, because it is difficult to construct a drainage channel to Cau River far from Dong Anh urban area.

According to the river flow record, yearly average flow of Ca Lo River is recorded between 19.1 m³/day and 36.2 m³/day between 1965 and 1973. Half of the minimum yearly average flow, 9.6 m³/day (829,440 m³/day) is adopted as Ca Lo River Flow for the calculation. The results of calculation are as shown below.

Prediction of BOD Concentration in Ca Lo River

		1997	2010	2020
BOD Pollution Load	kg/d	19,359	54,425	94,940
Wastewater Generation	m ³ /d	35,965	131,167	260,393
River Flow	m ³ /d	829,440	829,440	829,440
Incremental BOD concentration from 1997	mg/L	0	+7.3	+13.9
Expected BOD Concentration	mg/L	2.8 – 4.8*	10.1 – 12.1	16.7 – 18.7
Evaluation		U	S	S

Note: U: unpolluted, SP: slightly polluted, P: polluted

BOD values measured under the Study in 1999.

Due to development in Dong Anh Urban Area, Ca Lo River will become "Slightly Polluted".

3) Red River & Duong River

Only 305 ha of "Outside Red River Dyke Area" is located in the basin of Red River in the Study Area. According to the evaluation as shown below, "Outside Red River Dyke Area" will not have a serious impact on Red River.

Calculation of Incremental BOD Concentration in Red River

		1997	2010	2020
BOD Pollution Load	kg/d	3,568	4,028	3,900
Wastewater Generation	m ³ /d	4,461	6,042	6,500
River Flow	m ³ /d	143 million	143 million	143 million
Incremental BOD concentration from 1997	mg/L	0	+0.0006	+0.0005
Expected BOD concentration	mg/L	2.8 – 5.2	2.8 – 5.2	2.8 – 5.2
Evaluation		U	U	U

Note: U: unpolluted, SP: slightly polluted, P: polluted

“Red River Right Bank” may have an impact on Red River through Nhue River at the junction between Red River and Nhue River about 100 km downstream of the Study Area. However, this impact cannot be mentioned in the study.

Duong River basin is not included in the Study Area because long dykes are constructed along both sides of Duong River. Water quality of Duong River would not be affected by activity in the Study Area.

4) Nhue River upstream

Nhue River upstream is defined as the route from the beginning of the river to the points of the junction with To Lich River. The basin of Nhue River upstream of the Study Area consists of 5850 including Environmental Zone 2 “Red River Right Bank – North West”. The BOD concentration caused by other areas is calculated as below.

Incremental BOD Concentration of Nhue River Upstream

		1997	2010	2020
BOD Pollution Load	kg/d	21,088	37,791	47,236
Wastewater Generation	m ³ /d	55,745	109,653	139,791
River Flow	m ³ /d	691,200	691,200	691,200
Incremental BOD concentration from 1997	mg/L	0	+4.2	+6.2
Expected BOD concentration	mg/L	3.2 – 5.8	7.4 – 10.0	9.4 – 12.0
Evaluation	mg/L	U	U	S

Note: U: unpolluted, SP: slightly polluted, P: polluted

Present BOD value of Nhue River upstream is about 3.2 – 5.8 mg/L. The river water quality will deteriorate gradually until 2020, and expected to be in the level of "Slightly-polluted" in 2020.

(2) Water Bodies in Red River Right Bank

1) To Lich River System

To Lich River System consists of To Lich River, Lu River, Set River and Kim NgU River. The basin of the To Lich River System is divided into six areas, and calculations for the prediction are carried out at six points on the rivers. BOD pollution load generation and wastewater generation amount for each area are calculated as shown below.

BOD Pollution Load Generation and Wastewater Generation in To Lich River System

	Catchment (ha)	BOD Pollution Load (BOD kg/day)			Wastewater Amount (m ³ /day)		
		1997	2010	2020	1997	2010	2020
To Lich(Upper)	1,690	19,226	24,558	26,434	57,678	80,371	88,114
Lu(Upper)	500	8,181	10,029	10,592	24,544	32,823	35,308
Set&Kim (Upper)	1,033	15,521	18,832	19,890	46,564	61,633	66,300
To Lich(middle)	770	4,900	6,833	8,427	14,400	21,877	27,568
Kim(middle)	1,817	7,750	9,690	11,522	20,053	26,411	32,005
To Lich(down)	1,010	3,760	4,751	4,812	10,717	14,664	14,910

BOD concentration for each point is predicted as shown below.

BOD Concentration of To Lich River System

	(BOD mg/L)		
	1997	2010	2020
Up Stream			
U1 (To Lich River)	44	44	45
U2 (Lu River)	49	48	48
U3 (Set River)	48	47	47
U4 (Kim NgU River)	48	47	47
Middle Stream			
M1 (To Lich River)	43	44	45
M2 (Kim River)	40	41	42
Downstream			
D1 (To Lich River)	40	42	42

All points of To Lich River System are classified as definitely "Polluted".

2) Nhue River Lower

Water quality prediction of Nhue River upstream was carried out above. At the junction between Nhue River and To Lich River, the water of two rivers are mixed. BOD concentration of Nhue River after mixture with To Lich River is calculated as shown below.

BOD Concentration of Nhue River after Junction with To Lich River

		1997	2010	2020
To Lich River*				
BOD Concentration	mg/L	40	42	42
River Flow	m ³ /d	310,356	374,179	400,605
Nhue River*				
BOD Concentration	mg/L	3.2 – 5.8	10.8 – 13.4	14.3 – 16.9
River Flow	m ³ /d	1,290,000	1,290,000	1,290,000
Nhue River				
Expected BOD concentration	mg/L	10.9 – 13.6	20.2 – 22.8	24.2 – 26.8
Evaluation		S	S	P

Note: U: unpolluted, SP: slightly polluted, P: polluted

As calculated above.

3) Other Area

The average BOD concentration in water bodies such as small rivers and canals in the basin of Nhue River upper is calculated as shown below.

Average BOD Concentration in Urban Area in the Basin of Upper Nhue River

		1997	2010	2020
BOD Pollution Load	kg/d	19,290	29,086	37,473
Wastewater Generation	m ³ /d	50,350	101,092	128,832
Natural Flow	m ³ /d	199,520	199,520	199,520
Expected BOD concentration	mg/L	18	21	25
Evaluation		S	S	S

Note: U: unpolluted, SP: slightly polluted, P: polluted

The area in Red River Right includes "Tu Liem Suburban Area" and "Thank Tri Suburban Area". Predictions for both areas are as shown below.

Average BOD Concentration in Tu Liem Suburban Area

		1997	2010	2020
BOD Pollution Load	kg/d	3,663	5,776	6,757
Wastewater Generation	m ³ /d	4,578	9,452	11,261
Natural Flow	m ³ /d	75,720	75,720	75,720
Expected BOD concentration	mg/L	12	16	18
Evaluation		S	S	S

Note: U: unpolluted, SP: slightly polluted, P: polluted

Average BOD Concentration in Thanh Tri Suburban Area

		1997	2010	2020
BOD Pollution Load	kg/d	8,695	14,309	17,752
Wastewater Generation	m ³ /d	11,668	24,106	30,254
Natural Flow	m ³ /d	159,780	159,780	159,780
Expected BOD concentration	mg/L	13	18	21
Evaluation		S	S	S

Note: U: unpolluted, SP: slightly polluted, P: polluted

Water bodies in these suburban areas are expected to deteriorate gradually, but still be within "Slightly polluted" in 2020.

(3) Water Bodies in Red River / Duong River Left Bank

The area covers "Environmental Zone 4: Dong Anh Urban Area". As the area is developing, the existing irrigation and drainage channels will be reconstructed to meet the new development requirements. Therefore, the condition of water bodies cannot be expected to be maintained. It is assumed that pollution runoff in the area is same as that of the To Lich River Basin. Predicted water quality is as shown below.

Calculation of Average BOD Values in Red River/Duong River Left Bank Area

	unit	1997	2010	2020
BOD Load	kg/day	19,090	51,689	91,181
Wastewater Generation	m ³ /day	36,588	126,391	253,471
Natural River Flow	m ³ /day	496,900	496,900	496,900
Expected BOD Concentration	m ³ /day	10	19	26
Evaluation		U	S	P

Note: U: unpolluted, SP: slightly polluted, P: polluted

As shown below, the water environment in the area is expected to deteriorate rapidly until 2020, if no countermeasures are taken.

(4) Water Bodies in Duong River Right Bank

The area covers "Environmental Zone 5: Gia Lam Urban Area". As the area is developing, the existing irrigation drainage channels will be reconstructed to meet the new development requirements. Therefore, the condition of water bodies cannot be expected to be maintained. Predicted water quality is as shown below.

Calculation of Average BOD Values in Duong River Right Bank Area

	unit	1997	2010	2020
BOD Load	kg/day	11,145	23,384	40,692
Wastewater Generation	m ³ /day	25,587	60,538	115,050
Natural River Flow	m ³ /day	193,340	193,340	193,340
Expected BOD Concentration	m ³ /day	13	21	28
Evaluation		S	S	P

Note: U: unpolluted, SP: slightly polluted, P: polluted

As shown below, water environment in the area is expected to deteriorate rapidly until 2020, if no countermeasures are taken.

(5) Water Bodies in Soc Son

It is expected that the Unit BOD Load generation rate will increase from 0.41 kg/ha/day in 1997 to 1.03 kg/ha/day. The BOD load generation will still be low in comparison with the present condition in Dong Anh Urban Area (0.83 kg/ha/day) and Gia Lam Urban Area (2.16 kg/ha/day). The water bodies would be "Unpolluted".

	unit	1997	2010	2020
BOD Load	kg/day	12,125	25,011	19,157
Wastewater Generation	m ³ /day	25,587	60,538	115,050
Natural River Flow	m ³ /day	590,420	590,420	590,420
Expected BOD Concentration	m ³ /day	7	9	10
Evaluation		U	U	U

Note: U: unpolluted, SP: slightly polluted, P: polluted

(6) West Lake

Due to lack of detailed information about environmental mechanisms in West Lake, prediction of future lake water quality is difficult. According to the estimate of BOD pollution load generation in Ho Tay area, the generation amount will increase about 1.9 times in 2010 and 2.3 times in 2020, compared with generation in 1997. Later on, the quality of the lake is expected to deteriorate rapidly, if no countermeasures are taken.

(7) Overall Estimates

The results of the estimates of future water pollution prediction are summarized below:

Prediction without Countermeasures

		1997	2010	2020
Zone 1 Old City Center	To Lich River Lu River Set River Kim River	P	P	P
Zone 2 Red River Right Bank - North West	Nhue River (upper) & Other	U S	S S	S P
Zone 3 Red River Right Bank - South	To Lich River Lu River Set River Kim River	P	P	P
Zone 4 Dong Anh Urban Area	Van Tri Lake & Other	U	S	P
Zone 5 Gia Lam Urban Area	Bac Hong River & Other	S	S	P
Zone 6 Sub-Urban Area				
Soc Song		U	U	U
Dong Anh		U	S	P
Gia Lam		S	S	P
Tu Liem		S	S	S
Thanh Tri		S	S	S
Zone 7 Ho Tay Area		S	P	P
Major River	Cau River Ca Lo River Red River Duong River Nhue River (Lower)	U U U U S	U S U U S	U S U U S

Note: Un-polluted, S: Slightly Polluted, P: Polluted

Figure 3.2.1 and 3.2.2 present Future Water Pollution Maps showing the prediction of BOD pollution condition of major rivers and urban rivers in 2010 and 2020, respectively. Figure 3.2.3 and 3.2.4 present Future Water Pollution Maps showing the prediction of water pollution condition in each area in 2020 and 2020, respectively.

Table 3.2.1 Future Development Plan of Industrial Zone

Urban Unit	Name of Industrial Zone	Present	2005	2010	2020
Zone 2		98.6	256.0	316.0	426.0
16	Cau Dien Mai Dich Industrial Zone	27.0	77.0	77.0	77.0
16	Chem Industrial Zone	15.0	20.0	20.0	20.0
16	Sourth Thang Long Industrial Zone	0.0	100.0	160.0	270.0
19	Thuong Dinh Road No. 6 Industrial Zone	56.6	59.0	59.0	59.0
Zone 3		190.7	226.7	226.7	226.7
21	Thuong Dinh Road No. 6 Industrial Zone	37.7	39.2	39.2	39.2
23	Minh Khai, Vinh Tuy, Mai Dong Industrial Zone	81.0	101.5	101.5	101.5
23	Truong Dinh, Hoang Mai Industrial Zone	32.0	32.0	32.0	32.0
22	Cau Buou Industrial Zone	40.0	54.0	54.0	54.0
Zone 4		70.0	300.0	500.0	895.0
37	Dong Anh Industrial Zone	70.0	150.0	280.0	545.0
30	North Thang Long Industrial Zone	0.0	150.0	220.0	350.0
Zone 5		42.0	310.0	380.0	510.0
26	Duc Giang, Gia Lam, Cau Duong, Yen Vien Industrial Zone	18.0	80.0	80.0	80.0
26	Sai Don A	24.0	80.0	80.0	80.0
26	Sai Don B		150.0	220.0	350.0
Rural		40.0	150.0	260.0	480.0
	Van Dien, Phap Van Industrial Zone	40.0	50.0	50.0	50.0
	Noi Bai Industrial Zone	0.0	100.0	210.0	430.0
TOTAL		441.3	1,242.7	1,682.7	2,537.7

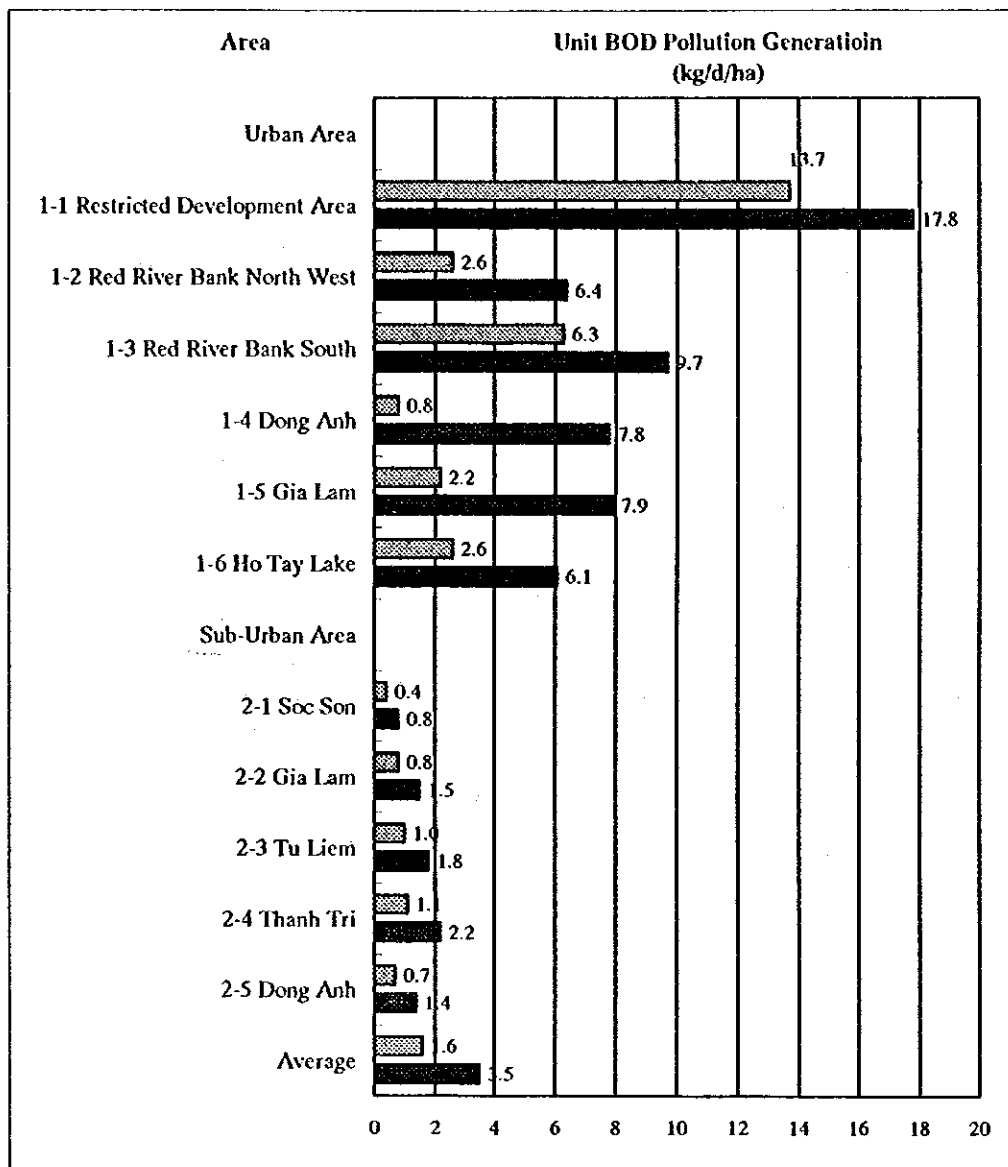
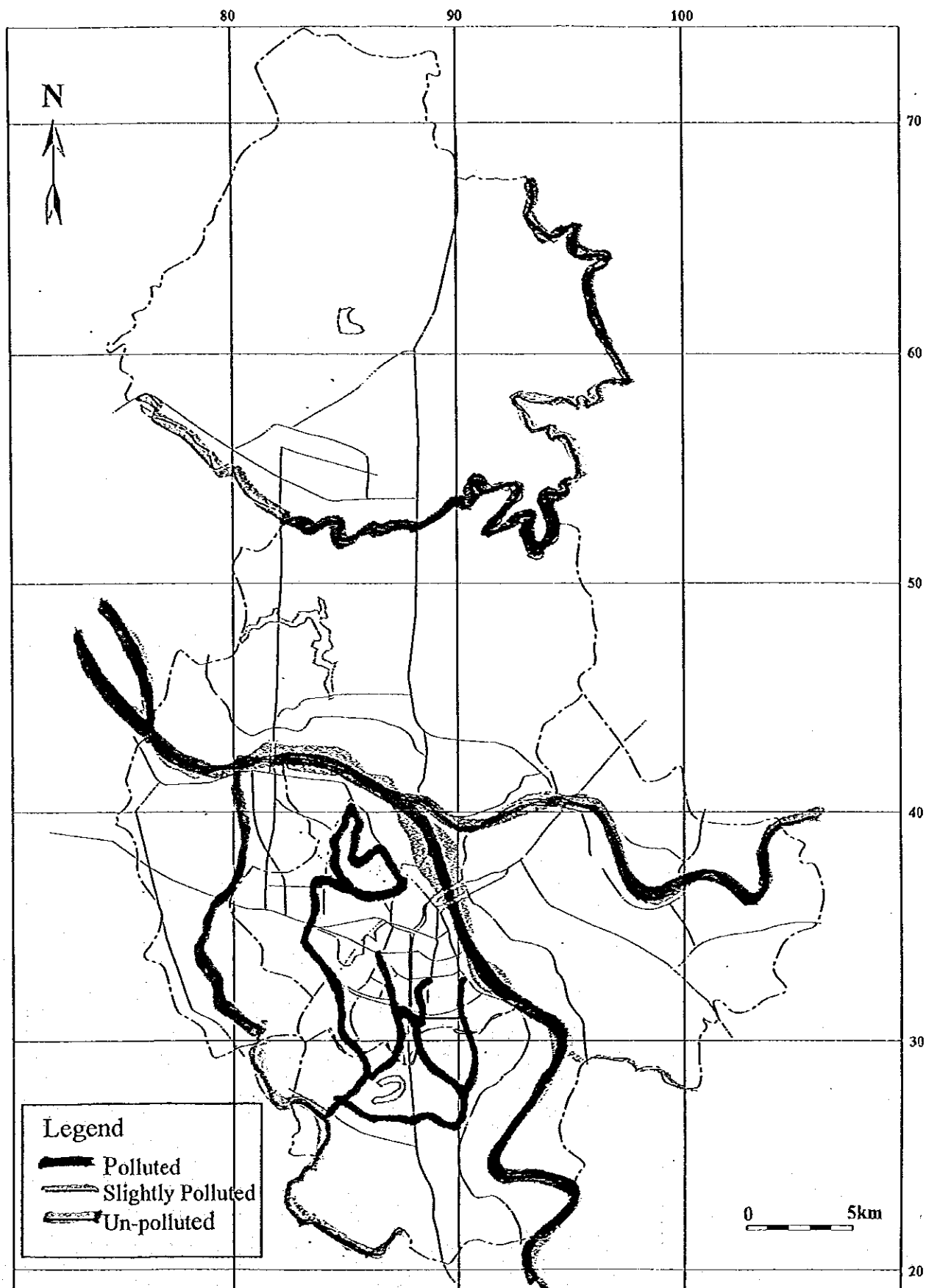


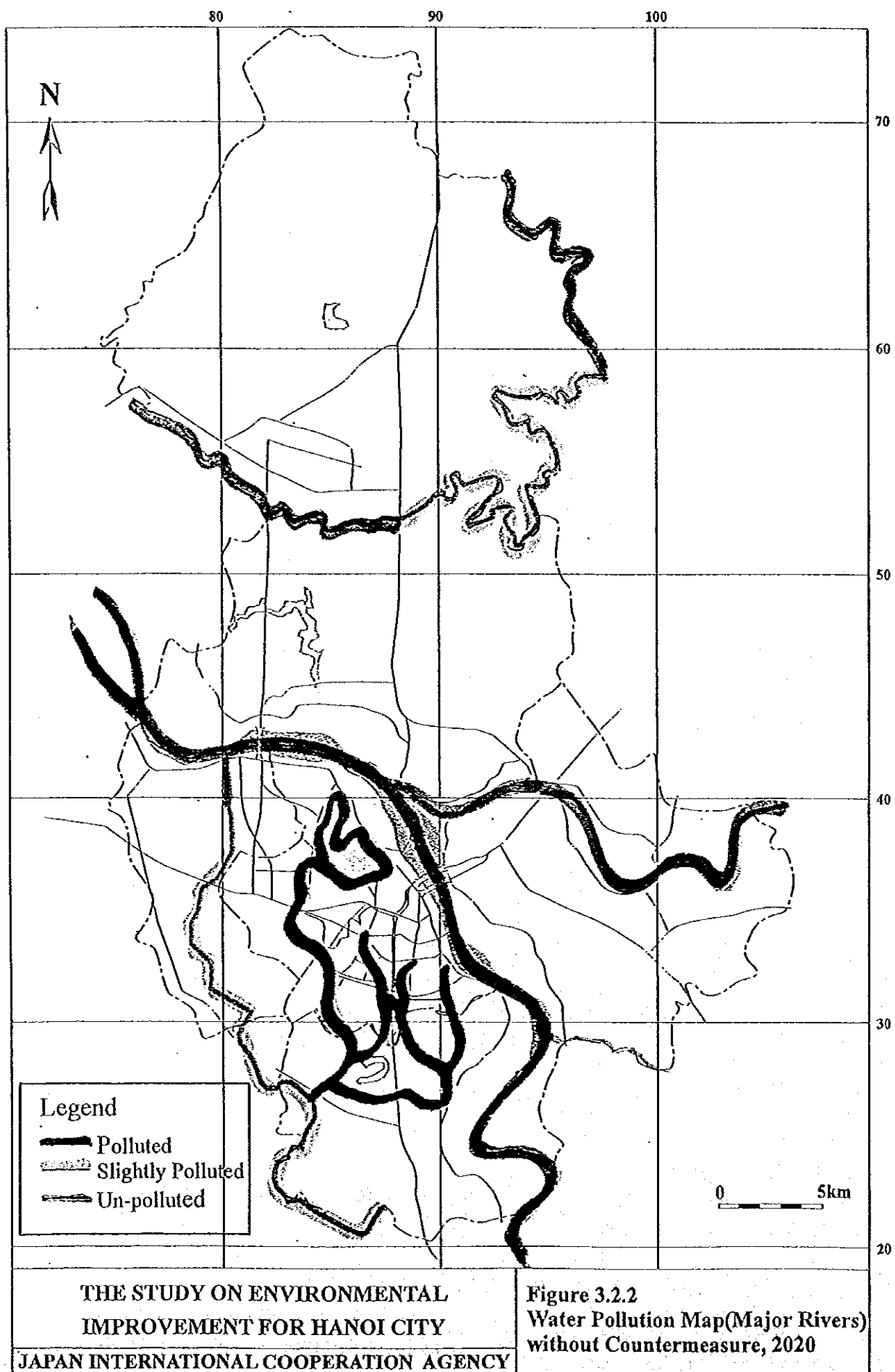
Figure 3.2.0 Unit BOD Pollution Generation comparing between 1997 and 2020

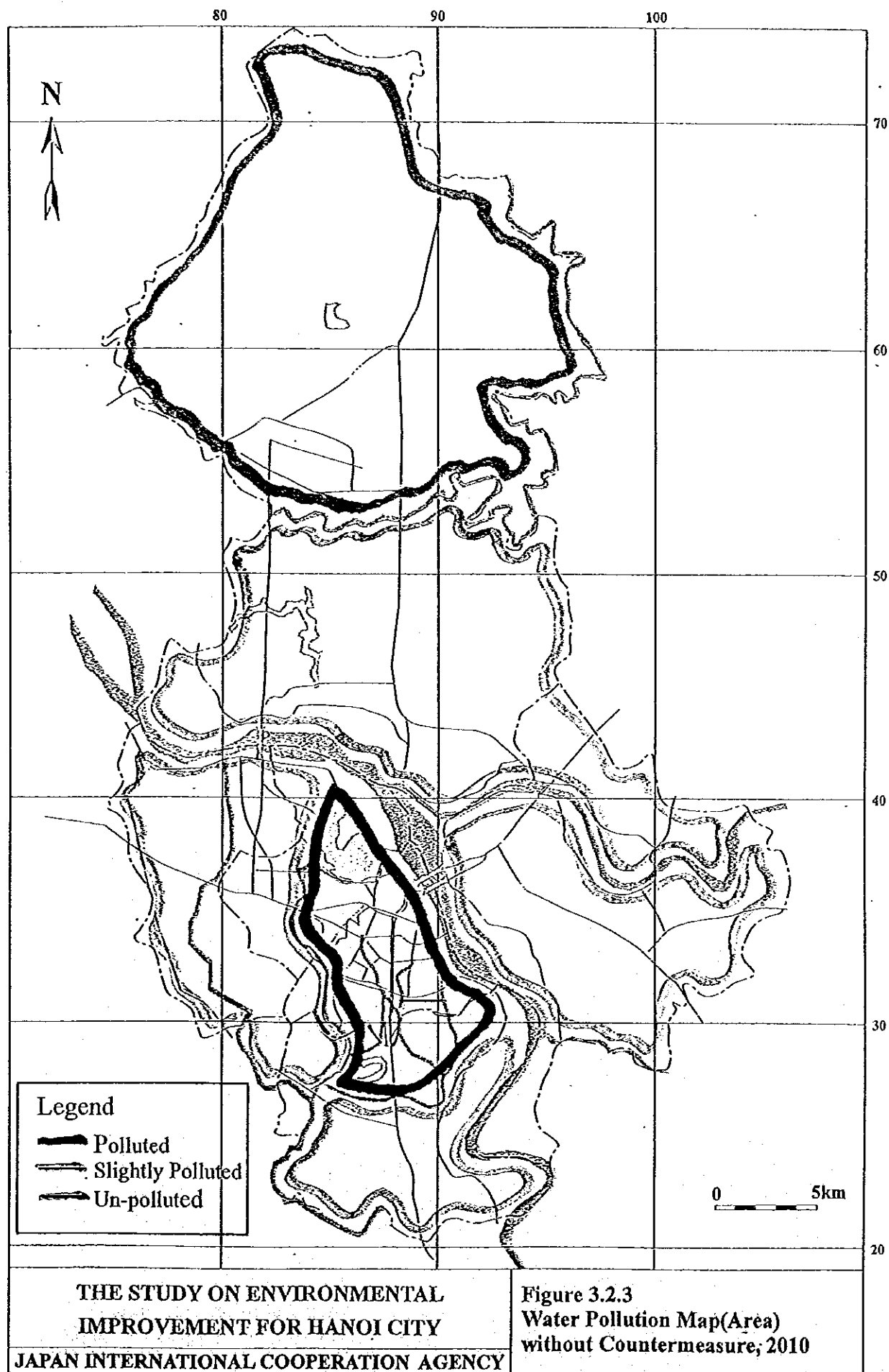


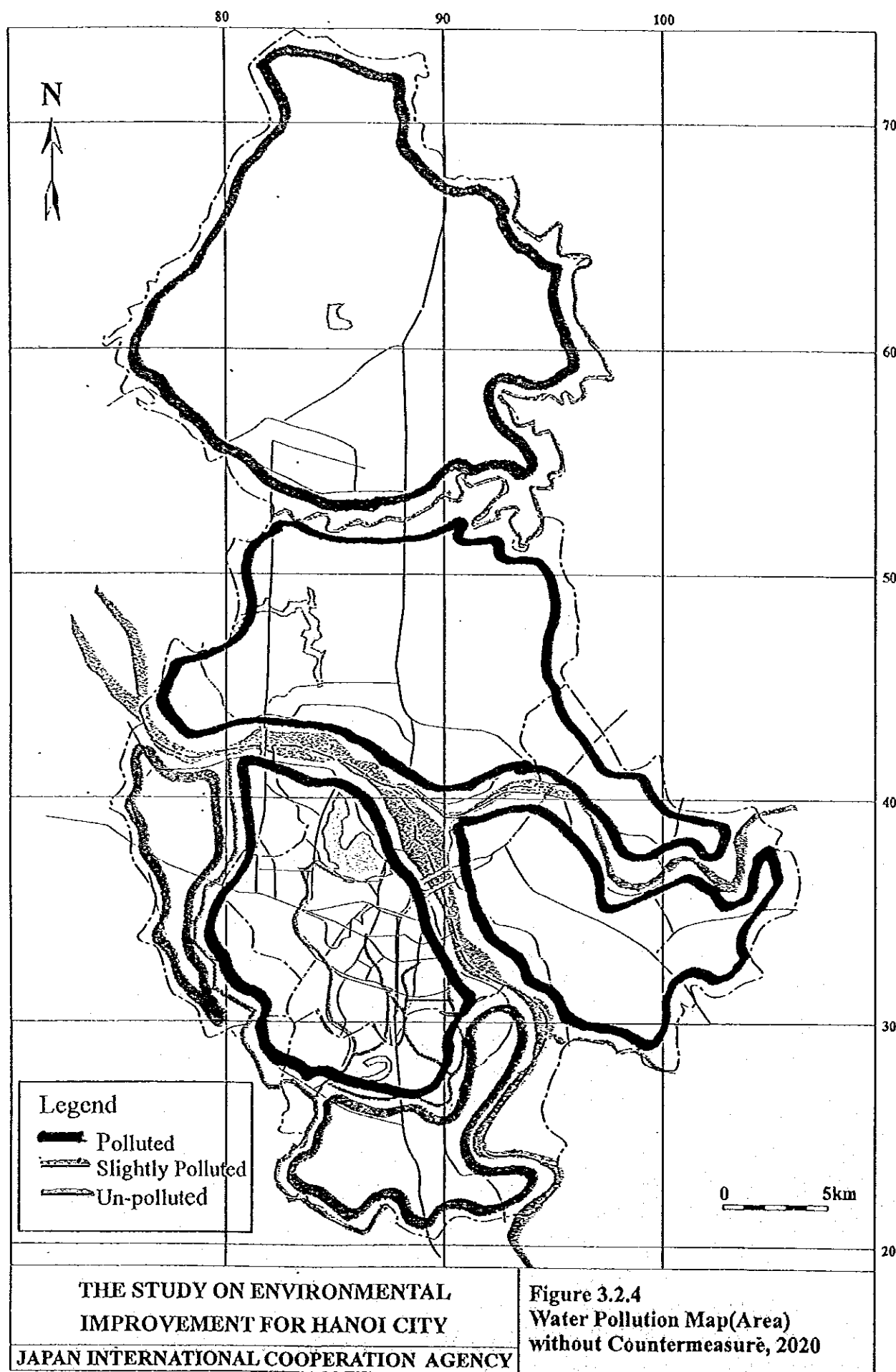
THE STUDY ON ENVIRONMENTAL
IMPROVEMENT FOR HANOI CITY

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 3.2.1
Water Pollution Map(Major Rivers)
without Countermeasure, 2010







3.3 Expected Air Quality in the Future without Counter-measure

This section presents the estimates of future air pollution loads for 2010 and 2020 and their potential impacts on air quality. No countermeasures were considered and the same basic air emission factors used to evaluate present air emission were used. This represents somewhat a worse case situation especially for industrial emissions since improvements to existing facilities are already planned and new sources will be less polluting than the existing ones.

3.3.1 Estimation of the Pollution Load Generation and Emission

(1) Domestic emissions

Total emissions from household was estimated by simply increasing the amount of fuel used by the same proportion as population increased in each environmental zone. As family income increases, it is believed that energy consumption per capita for cooking will remain the same. It is also reasonable to assume that as family income increases, many families will prefer the use of electricity or gas over coal for cooking purposes. This means that even without countermeasures, the actual emissions of air pollutants will increase at a slower rate than population. For purposes of estimating for a worst case scenario, fuel type switching in relation to family income is neglected here. The same pollutant emission factors and the same fuel use frequency by environmental zone than in the section presenting the actual loads were used in the estimation of pollutant loads for 2010 and 2020. The Old City Center Environmental zone and especially the Ancient Quarter Area population unit has the highest emission density ($t/y/km^2$), with values equal to 10 and 25 times the overall average for all the study area. Results for present and future conditions for 2010 and 2020 are presented in Tables 3.3.1 and 3.3.2.

(2) Industrial emissions

Future air emissions load estimates from industrial sources have a large potential of increase. In addition to emissions from existing sources, there will be a large number of new sources. The majority of these new sources will be located in existing industrial zones that will expand or in new industrial zones to be developed. For each existing and planned industrial zone, the 2020 Master Plan for Hanoi City defines estimated number of employees and the type of industrial production. As for most of the existing industry, none of the planned industrial installations can be qualified as heavy industry in relation to atmospheric emissions, such as: cement (clinker) manufacturing, petroleum refining, primary metal smelting, thermal power electricity production. Most of the planned industries are manufacturing plants that usually do not require large amounts of energy. Individually, each of these

new industrial sources can be qualified as a minor source, but as a whole they could still be a significant contributor to atmospheric emissions, especially for particulate matter and sulfur dioxide if coal and heavy oil remain the privileged sources of energy.

Based on the coal and oil consumption from actual industries and area of present industrial zones, an average emission factor per unit area (t/y/ha) was calculated for each contaminant (CO, NO_x, TSP and SO₂). Emission factors are presented in Table 3.3.3. Total suspended particulate (TSP) from brick and tile factories were excluded from the calculation of emission factors per unit area.

These emission factors, with the planned area of new industrial zones, were then applied to estimate industrial air pollution loads for 2010 and 2020. Results are presented in Tables 3.3.4 and 3.3.5. Almost all the increase in industrial emissions will occur in the new industrial zones: North and South Thang Long, Sai Dong B, Dong Anh, and Soc Son. Industrial emissions in the present urban area should remain practically the same. Globally, industrial emissions from fuel combustion could increase by a factor of 5 to 6 between 1997 and 2020 if no reduction measures are implemented.

(3) Motor vehicles emissions

Mobile sources are already the dominant source of carbon monoxide, nitrogen oxides, and lead in Hanoi. They are also a major emitter of sulfur dioxide and dust (resuspension) to the atmosphere. The transportation sector is already the most important source of regional air pollution in Hanoi. With economic growth, atmospheric emissions from the transportation sector have a large increase potential. Total running kilometers by motor vehicles is estimated to increase by 3.5 between 1997 and 2020.

Prediction of future emission loads without countermeasures are based on the "The Master Plan of Urban Transport for Hanoi City in Viet Nam (MPUT)" sponsored by JICA in 1997 and on the same emission factors used for estimating 1997 pollution loads from motor vehicles. The population and land use frameworks in the transport study and in this Study are quite different. For population, the urban transport master plan used a total population for Hanoi of 4.7 millions in 2015, including the town of Ha Dong. This town, even if not in the administrative boundaries of Hanoi, is in fact a suburb of Hanoi.

In this Study, the suburb of Ha Dong is not included in the Study area and the population of Hanoi is considered to be 2.82 millions in 2010 and 3.51 millions in 2020, according to the Hanoi City Master Plan for 2020. Compared to the MPUT for 2015, the total number of trips per year in our predictions for 2010 and

2020 must, therefore, be smaller. The average trip length should be slightly shorter because of a smaller urban expansion. Also, the trip share for motor vehicles should be slightly higher in 2020 than in the MPUT because of a longer economic growth period.

The following assumptions were used to estimate total kilometers traveled by transport mode in Hanoi in 2010 and 2020, based on the figures of the MPUT for 2015:

- total number of trips is proportional to population.
- motor vehicle trip share is lower in 2010 and higher in 2020 than in the MPUT for 2015.
- average trip length is smaller than in the MPUT in 2010 and 2020 because of smaller urban expansion.
- vehicle occupancy is unchanged.
- share of bus trips and average bus trip length remain the same (no promotion of public transport).

The share of trips for cars and motorcycles was estimated by interpolation and extrapolation from the estimates given in the MPUT for 1995 and 2015. Therefore, the share of trip by personal motor vehicle (motorcycle, car) increases from 2010 to 2020, mainly because of economic growth. MPUT does not give the average trip length by mode. The average all mode trip length for 2010 and 2020 were set in between the MPUT estimates for 1995 and 2015, because of a much smaller urban expansion in our macro frame compared to the one used in the MPUT. Trips length by mode were then determined by trial and error until the average all mode trip length matches the previously set value.

Results from these calculations are presented in Table 3.3.6 for the 1997, 2010 and 2020 cases. The 1995 and 2015 scenarios of the MPUT are presented for comparison. The 1995 MPUT and our 1997 cases were already discussed from the present situation of air emission.

Future pollution loads predictions without countermeasures are presented in Table 3.3.7. They only consider the estimated changes in running kilometers per transport mode and an increase in fuel consumption of 5% for 2010 and 10% for 2020 because of slower traffic and congestion. This load estimate has also the following limitations:

- changes in the vehicle fleet age distribution are not considered: as a vehicle gets older, air emissions increase;
- traffic flow conditions are considered only by increasing by 5% or 10% fuel consumption: in congested traffic where vehicles stop and go, air emissions per kilometer traveled are higher.

- for buses, the estimated running kilometers underestimates the actual distance traveled by the buses. For example, if on their routes the buses make long distances with very few passengers, then the distance traveled is not entirely accounted for.
- changes in fuel consumption of vehicles are not considered. For example, if motorcycle engines become more powerful, their fuel consumption will increase and so will their air emissions.

(4) Summary of future prediction loads without countermeasures

Table 8 presents the summary of future emissions loads for Hanoi. Emission loads will increase between 2 and 4.8 times the present levels. Domestic emissions will increase but will become much less important compared to transport and industrial emissions. Domestic emissions will increase by a factor of 1.43 by 2020, while industrial and transport emissions will increase, respectively, by a factor of 5.7 and 4.2. The increase from mobile sources could get much larger if the proportion of old vehicles in the fleet increases or if motorcycles become more powerful.

3.3.2 Assessment of the Ambient Environment Conditions

In order to assess future general air quality in Hanoi, an air dispersion model was used for the estimated atmospheric emissions presented in the previous section. As in Part 2 (Section 1.2.1) of this Report, domestic and transport emissions were distributed in each environmental zone following the population distribution by zone. Industrial fuel combustion emissions were distributed in each industrial zone according to area of each industrial zone. The model was run for all contaminants for years 2010 and 2020.

As for the assessment of present conditions, results are representative of general air quality in an area. Concentrations near industrial zones or isolated industrial sources, major roadways or high density residential areas using coal should be higher than presented here.

Table 3.3.9 presents the maximum calculated concentrations over one year for the whole Study area for years 2010 and 2020 without applying countermeasures. When a maximum calculated concentration occurs in an industrial zone (IZ) and is above a standard value, the highest calculated value outside an IZ is also indicated. In general, maximum calculated lead, CO and NO₂ occur in the central area while maximums for SO₂, TSP, and PM10 occur near industrial zones.

For 2020, maximum results, occurring mostly in the central area, are about two times higher than those calculated for the present (1997) situation, even if

emissions increase by a factor of almost five. This is because emissions are distributed over a larger area.

Based on the calculations, the following conclusions can be made for 2020:

- Annual TSP levels now reach values close to four times the annual standard in the central area and short term average are even higher near industrial zones when compared to standard. Same conclusion can be made for PM10.
- SO₂ could reach values over standards for all averaging periods in the central area and around industrial zones.
- NO₂ levels could also be above standard in the central area.
- CO levels are getting closer to the 8 hours standard in the central area. This mean they could sometimes exceed the standard values locally near heavy traffic roadways.
- Lead is below standard with values remaining at about 40% of standards.

The resulting air pollution maps for TSP and PM10 for 2010 and 2020 without countermeasures are presented in Figures 1 and 2, with the pollution for the present situation. The maps clearly show the expansion of the polluted zone. Results of air pollution classification per pollutant for 2010 and 2020 are presented by Environmental zone in the following tables.

Evaluation of Air Quality by Environmental Zone in 2010

Environmental Zone	CO	NO ₂	SO ₂	TSP	PM10	Lead	All
1 Old City Center	U	P-SP	U	P	P	U	P
2 Red River Right Bank North-West	U	U	U	P	P-SP	U	P
3 Red River Right Bank South	U	U-SP	U	P	P	U	P
4 Dong Anh urban area	U	U	U	P	SP-U	U	P
5 Gia Lam urban area	U	U	U-SP	P-SP	P-SP-U	U	P-SP
6 Rural Areas							
Tu Liem	U	U	U	P-SP	SP-P-U	U	P-SP
Soc Son	U	U	U-SP	U-P-SP	U-SP-P	U	U-SP-P
Dong Anh	U	U	U	U-P	U-SP-P	U	U-SP-P
Thanh Tri	U	U	U	SP-U-P	U-SP-P	U	SP-U-P
Gia Lam	U	U	U	SP-U	U-SP	U	SP-U
7 Ho Tay area	U	U-SP	U	P	P-SP	U	P

Note: U: unpolluted, SP: slightly polluted, P: polluted

When several classes are indicated for the same environmental zone, the first one covers the largest area in the zone.

Evaluation of Air Quality by Environmental Zone in 2020

Environmental Zone	CO	NO ₂	SO ₂	TSP	PM10	Lead	All
1 Old City Center	U	P	P-U	P	P	U	P
2 Red River Right Bank North-West	U	SP	U-SP	P	P	U	P
3 Red River Right Bank South	U	SP-P	U-SP-P	P	P	U	P
4 Dong Anh urban area	U	U-SP	U-SP	P	P	U	P
5 Gia Lam urban area	U	U-SP	U-SP-P	P	P	U	P
6 Rural Areas							
Tu Liem	U	U-SP	U-SP-P	P	P-SP	U	P
Soc Son	U	U-SP	U-SP-P	P-SP-U	SP-P-U	U	P-SP-U
Dong Anh	U	U-SP	U-SP	SP-P	SP-P	U	SP-P
Thanh Tri	U	U-SP	U	P-SP	SP-P	U	P-SP
Gia Lam	U	U-SP	U-SP	P-SP	SP-P	U	P-SP
7 Ho Tay area	U	SP	U	P	P	U	P

Note: U: unpolluted, SP: slightly polluted, P: polluted

When several classes are indicated for the same environmental zone, the first one covers the largest area in the zone.

The evolution (deterioration) of air quality from 1997 to 2010 and 2020 for each environmental zone is presented as below.

Air Quality by Environmental Zone for 1997, 2010 and 2020 without countermeasures

Environmental Zone	1997	2010	2020
1 Old City Center	P	P	P
2 Red River Right Bank North-West	U-P-SP	P	P
3 Red River Right Bank South	P-U-SP	P	P
4 Dong Anh urban area	U	P	P
5 Gia Lam urban area	U-SP	P-SP	P
6 Rural Area			
Tu Liem	U	P-SP	P
Soc Son	U-SP-P	U-SP-P	P-SP-U
Dong Anh	U-SP	U-SP-P	SP-P
Thanh Tri	U-P	SP-U-P	P-SP
Gia Lam	U	SP-U	P-SP
7 Ho Tay area	U-P	P	P

Note: U: unpolluted, SP: slightly polluted, P: polluted

When several classes are indicated for the same environmental zone, the first one covers the largest area in the zone.

As seen in this table and figures 3.3.1 and 3.3.2, the polluted zones cover a much larger area in 2010 and 2020 compared to 1997. For 2010 and 2020, most of the Study area is considered as polluted by TSP and PM10. NO₂ pollution remains in the Old City Center and a "slightly polluted" zone expands in the surrounding zones from 2010 to 2020.

Table 3.3.1 Estimated domestic fuel consumption and atmospheric emissions for 2010 and 2020

	1997	2010	2020
Fuel	Estimated Fuel Consumption (t/y)		
Coal	125,000	145,688	185,631
Wood	38,430	44,301	55,970
Kerosene	19,371	20,409	23,716
Gas	7,639	8,096	9,427
Pollutant	Estimated Pollutant Emission Load (t/y)		
SO ₂	1,335	1,547	1,962
NO _x	315	360	450
CO	8,908	10,339	13,131
TSP	1,483	1,721	2,185

Table 3.3.2 Estimated domestic atmospheric emissions for 2010 and 2020 by Environmental Zone

(Unit: t/y)

Environmental Zone	1997				2010				2020			
	SO ₂	NO _x	CO	TSP	SO ₂	NO _x	CO	TSP	SO ₂	NO _x	CO	TSP
1- Old City Center	425	115	2,792	466	381	103	2,502	418	368	100	2,422	404
2- Red River Right Bank - NW	156	34	1,049	174	196	43	1,322	220	226	50	1,523	253
3- Red River Right Bank - South	152	33	1,025	170	146	32	984	164	168	37	1,134	188
4- Dong Anh	67	15	453	75	186	41	1,250	208	397	87	2,673	444
5- Gia Lam	76	17	515	86	91	20	610	101	194	43	1,305	217
6- Rural Area	451	99	3,032	504	537	118	3,613	601	596	131	4,009	667
7- Ho Tay	8	2	42	7	11	3	57	10	12	4	66	11
Total Hanoi	1,335	315	8,908	1,483	1,547	360	10,339	1,721	1,962	450	13,131	2,185

Table 3.3.3 Emission factors for IZ fuel combustion

(Unit: t/y/ha)

SO ₂	NO _x	CO	TSP	PM10
6.33	4.29	1.11	18.38	13.78

Table 3.3.4 Estimated atmospheric emissions from industrial fuel combustion for 2010 and 2020 without countermeasures

(units: tons/year)

Year	Area of industrial zones (ha)	SO ₂	NO _x	CO	TSP	PM10
1997	441.3	2 794	1 893	489	8 111	6 083
2010	1642.7	10 400	7 047	1 820	30 192	22 644
2020	2537.7	16 067	10 886	2 812	46 642	34 982

Excluding TSP emissions from brick factories (82 000 t/y in 1995)

**Table 3.3.5 Estimated Atmospheric Emissions by Industrial Zone for 2010
and 2020 (fuel only)**

1997						(unit:t/y)
Industrial Zone	Area (ha)	SO ₂	NO _x	CO	TSP	PM10
Thuong Dinh	94.3	597	405	104	1 733	1 300
Minh Khai - Vinh Tuy	81	513	347	90	1 489	1 117
Truong Dinh - Hoang Mai	32	203	137	35	588	441
Van Dien - Phap Van	40	253	172	44	735	551
Cau Dien - Mai Dich	27	171	116	30	496	372
Chem	15	95	64	17	276	207
Cau Buou	40	253	172	44	735	551
Duc Giang - Gia Lam - Yen Vien	18	114	77	20	331	248
North Thang Long						
South Thang Long						
Sai Dong A	24	152	103	27	441	331
Sai Dong B						
Dong Anh	70	443	300	78	1 287	965
Soc Son						
Total	441	2 794	1 893	489	8 111	6 083
2010						
Industrial Zone	Area (ha)	SO ₂	NO _x	CO	TSP	PM10
Thuong Dinh	98.2	622	421	109	1 805	1 354
Minh Khai - Vinh Tuy	101.5	643	435	112	1 866	1 399
Truong Dinh - Hoang Mai	32	203	137	35	588	441
Van Dien - Phap Van	50	317	214	55	919	689
Cau Dien - Mai Dich	77	488	330	85	1 415	1 061
Chem	20	127	86	22	368	276
Cau Buou	54	342	232	60	993	744
Duc Giang - Gia Lam - Yen Vien	80	507	343	89	1 470	1 103
North Thang Long	220	1 393	944	244	4 044	3 033
South Thang Long	160	1 013	686	177	2 941	2 206
Sai Dong A	80	507	343	89	1 470	1 103
Sai Dong B	220	1 393	944	244	4 044	3 033
Dong Anh	280	1 773	1 201	310	5 146	3 860
Soc Son	210	1 330	901	233	3 860	2 895
Total	1683	10 654	7 218	1 865	30 928	23 196
2020						
Industrial Zone	Area (ha)	SO ₂	NO _x	CO	TSP	PM10
Thuong Dinh	98.2	622	421	109	1 805	1 354
Minh Khai - Vinh Tuy	101.5	643	435	112	1 866	1 399
Truong Dinh - Hoang Mai	32	203	137	35	588	441
Van Dien - Phap Van	50	317	214	55	919	689
Cau Dien - Mai Dich	77	488	330	85	1 415	1 061
Chem	20	127	86	22	368	276
Cau Buou	54	342	232	60	993	744
Duc Giang - Gia Lam - Yen Vien	80	507	343	89	1 470	1 103
North Thang Long	350	2 216	1 501	388	6 433	4 825
South Thang Long	270	1 709	1 158	299	4 963	3 722
Sai Dong A	80	507	343	89	1 470	1 103
Sai Dong B	350	2 216	1 501	388	6 433	4 825
Dong Anh	545	3 451	2 338	604	10 017	7 513
Soc Son	430	2 722	1 845	476	7 903	5 927
Total	2538	16 067	10 886	2 812	46 642	34 982

Table 3.3.6 Summary of running kilometers and fuel consumption estimates

	1995 UTMP	1997	2015 UTMP	2010	2020
Population in Hanoi (millions)	2.4	2.48	4.68	2.82	3.51
Number of trips (10 ⁶ /y)	3,294	3,408	8,929	5,500	6,699
Average trip length by mode (km)					
All modes	5.27	5.47	6.47	5.78	6.32
Bicycle	2.5	2.5	2.5	2.0	2.0
Motorcycle	8.0	8.0	8.0	6.5	6.5
Car	11.0	11.0	11.0	10.0	10.0
Bus	18.0	18.0	8.0	18.0	18.0
Truck	15.0	15.0	15.0	15.0	15.0
Trip share by mode (%)					
Bicycle	61.3	57.9	31.8	35.0	25.0
Motorcycle	31.6	35.0	49.6	55.7	64.1
Car	0.7	0.8	2.7	2.0	3.0
Bus	5.6	5.6	14.0	5.6	5.6
Truck	0.8	0.8	2.0	1.7	2.3
Running Kilometers per year (10 ⁶ km/y)	11,312	12,102	35,640	19,689	26,060
Bicycle	4,808	4,698	6,759	3,667	3,190
Motorcycle	5,948	6,816	25,286	14,223	19,937
Car	88	103	902	379	693
Bus	139	144	417	231	281
Truck	329	340	2,277	1,189	1,959
Total motor vehicles	6,504	7,403	28,881	16,022	22,870
Estimated fuel consumption (t/y)					
Gasoline	97,190	111,591	467,700	262,293	403,544
Diesel	119,284	123,413	686,768	380,087	628,310

Basic fuel consumption (l/100 km)	Motorcycle	2
	Car	14
	Bus	30
	Truck	30

Table 3.3.7 Estimated Running kilometers and Air Emissions from transport sector

Base case - 1997

Transport Mode	Running km (10 ⁶ km/y)	SO ₂		NO _x		CO		TSP		PM ₁₀	
		g/km	t/y	g/km	t/y	g/km	t/y	g/km	t/y	g/km	t/y
Gasoline vehicles											
Moto	6 816	0.0074	50	0.3	2 045	20	136 320	0.14	954	0.09	611
Car	103	0.052	5	3	310	50.2	5 191	0.30	31	0.19	20
Total gasoline vehicles	6 919		56		2 355		141 511		985		631
Diesel vehicles											
Bus	144	2.5	360	15.7	2 258	7.4	1 064	2.9	417	2.9	417
Truck	340	2.5	850	15.7	5 340	7.4	2 517	2.9	986	2.9	986
Total diesel vehicles	484		1 210		7 598		3 581		1 404		1 404
Total all vehicles	7 403		1 266		9 953		145 093		2 389		2 034
Road resuspension								2.94	21 766	0.56	4 173
Total									24 155		6 207

2010 without countermeasures

Transport Mode	Running km (10 ⁶ km/y)	SO2		NOx		CO		TSP		PM10	
		g/km	t/y	g/km	t/y	g/km	t/y	g/km	t/y	g/km	t/y
Gasoline vehicles											
Moto	14 223	0.0078	111	0.315	4 480	21	298 691	0.147	2 091	0.09	1 338
Car	379	0.055	21	3.15	1 195	52.71	19 993	0.32	119	0.20	76
Total gasoline vehicles	14 603		131		5 675		318 685		2 210		1 415
Diesel vehicles											
Bus	231	2.625	606	16.485	3 808	7.77	1 795	3.045	703	3.0	703
Truck	1 189	2.625	3 120	16.485	19 593	7.77	9 235	3.045	3 619	3.0	3 619
Total diesel vehicles	1 420		3 726		23 401		11 030		4 323		4 323
Total all vehicles	16 022		3 858		29 077		329 715		6 533		5 737
Road resuspension								2.94	47 105	0.56	9 030
Total									53 638		14 767

Including a 5% increase in emission factors because of slower traffic and congestion

2020 without countermeasures

Transport Mode	Running km (10 ⁶ km/y)	SO ₂		NO _x		CO		TSP		PM ₁₀		
		g/km	t/y	g/km	t/y	g/km	t/y	g/km	t/y	g/km	t/y	
Gasoline vehicles												
Moto	19 937	0.0081	162	0.33	6 579	22	438 607	0.154	3 070	0.10	1 965	
Car	693	0.057	40	3.3	2 287	55.22	38 267	0.33	229	0.21	146	
Total gasoline vehicles	20 630		202		8 866		476 875		3 299		2 111	
Diesel vehicles												
Bus	281	2.75	774	17.27	4 859	8.14	2 290	3.19	898	3.2	898	
Truck	1 959	2.75	5 386	17.27	33 825	8.14	15 943	3.19	6 248	3.2	6 248	
Total diesel vehicles	2 240		6 160		38 684		18 233		7 145		7 145	
Total all vehicles	22 870		6 362		47 550		495 108		10 444		9 257	
Road resuspension								2.94	67 237	0.56	12 669	
Including a 10% increase in emission factors because of slower traffic and congestion								Total		77 681		22 146

Including a 10% increase in emission factors because of slower traffic and congestion

Table 3.3.8 Estimated air pollutant emissions (t/y) by sector of activity in Hanoi for 2010 and 2020

Units: tons/year

Base case : 1997

Sector of Activity	SO ₂	NO _x	CO	TSP	PM10	Lead
Industry(fuel combustion only)	2 794	1 893	489	8 111	6 083	--
Industry(process)*	--	--	--	82 000	16 400	--
Transport	1 266	9 953	145 093	2 389	2 034	22
Road dust resuspension	--	--	--	21 766	4 173	--
Domestic (fuel combustion)	1 335	315	8 908	1 483	1 483	--
Total	5 395	12 162	154 490	115 749	30 173	22

Without countermeasures: 2010

Sector of Activity	SO ₂	NO _x	CO	TSP	PM10	Lead
Industry(fuel combustion only)	10 654	7 218	1 865	30 928	23 196	--
Industry(process)*	--	--	--	82 000	16 400	--
Transport	3 858	29 077	329 715	6 533	5 737	52
Road dust resuspension	--	--	--	47 105	9 030	--
Domestic (fuel combustion)	1 547	360	10 339	1 721	1 721	--
Total	16 059	36 655	341 918	168 287	56 084	52

Without countermeasures: 2020

Sector of Activity	SO ₂	NO _x	CO	TSP	PM10	Lead
Industry(fuel combustion only)	16 067	10 886	2 812	46 642	34 982	--
Industry(process)*	--	--	--	82 000	16 400	--
Transport	6 362	47 550	495 108	10 444	9 257	81
Road dust resuspension	--	--	--	67 237	12 889	--
Domestic (fuel combustion)	1 962	450	13 131	2 185	2 185	--
Total	24 391	58 886	511 051	208 508	75 713	81

Note :

* from the estimated TSP emissions for 1995 for tile and brick manufacturing cited in "Report on the Current Condition of Air Environment in Hanoi City" (in Vietnamese), Center for Environmental Technology Consultancy, July 1998.

Table 3.3.9 Maximum calculated air pollutant concentrations in ambient air

2010 without countermeasures				Units: mg/m ³
Air Contaminant	Averaging Period			
	1 hour	8 hours	24 hours	1 year
CO	14.4 - Central below standard	5.6 - Central below standard	-- --	-- --
NO ₂	0.510 - Central above standard	--	0.135 - Central above standard	-- --
SO ₂	- IZ 0.500 - Central above standard	--	0.198 - IZ 0.080 - Central below standard	0.071 - IZ 0.033 - Central above standard
TSP	--	--	- IZ 0.652 - Central above standard	- IZ 0.297 - Central above standard
PM10	--	--	0.448 - IZ 0.223 - Central above standard	0.160 - IZ 0.096 - Central above standard
Lead	--	--	--	0.00030 below standard

2020 without countermeasures				Units: mg/m ³
Air Contaminant	Averaging Period			
	1 hour	8 hours	24 hours	1 year
CO	17.5 - Central below standard	6.6 - Central below standard	-- --	-- --
NO ₂	0.684 - Central above standard	-- -	0.175 - Central above standard	-- --
SO ₂	1.1 - IZ 0.55 - Central above standard	--	0.260 - IDZ 0.2 - Central below standard	0.099 - IDZ 0.040 - Central above standard
TSP	--	--	0.9 - IDZ 0.7 - Central above standard	0.355 Central - IDZ above standard
PM10	--	--	0.580 - IDZ 0.250 - Central above standard	0.219 - IDZ 0.100 - Central above standard
Lead	--	--	--	0.00036 below standard

Notes:

(1) IZ: in or near industrial zone in urban area; Central: in urban area

(2) These results are the maximum calculated values over the whole study area for a one year period. All these maximums occurs in the urban area of Hanoi or in the proximity of a IZ.

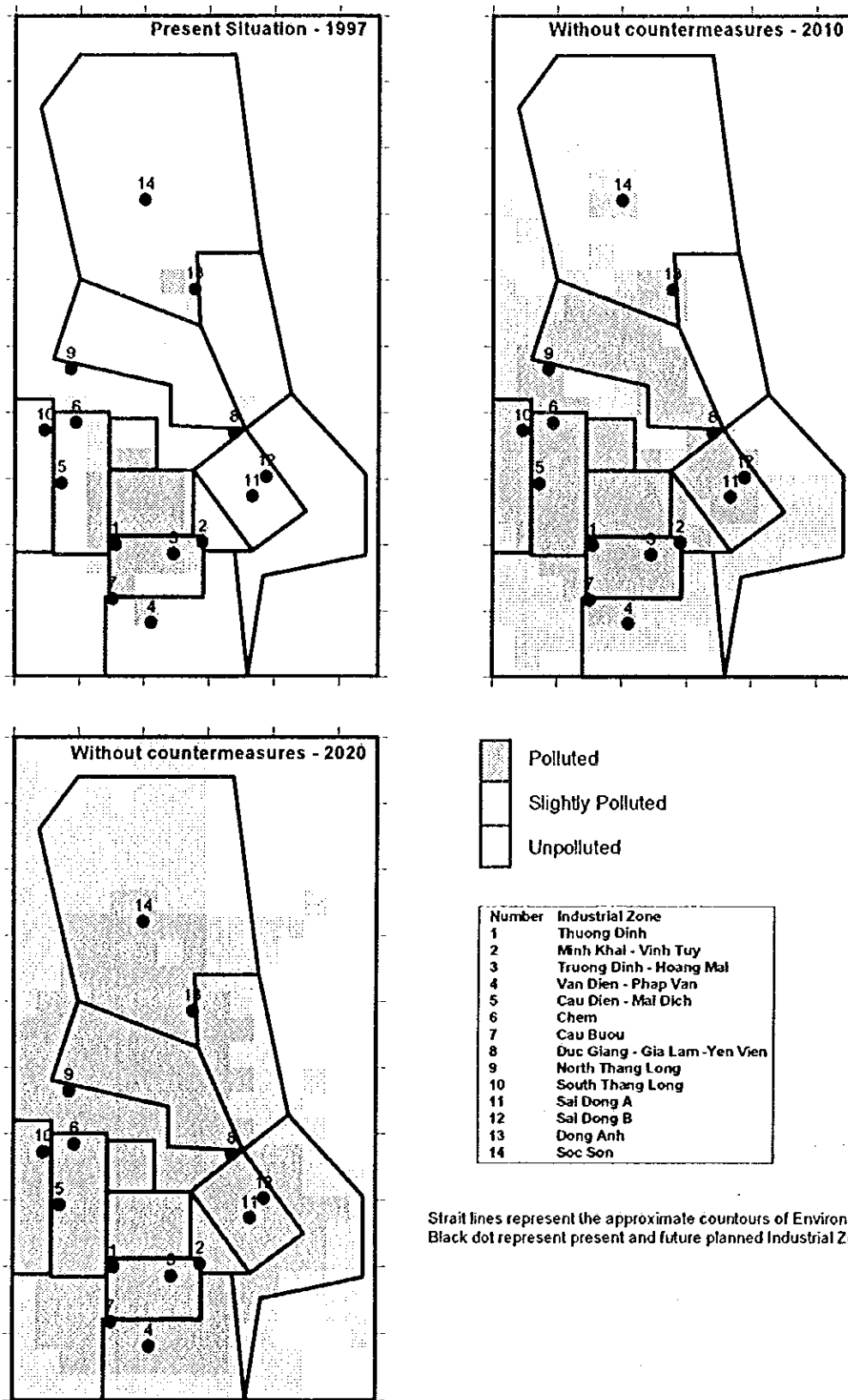


Figure 3.3. ITSP Air Pollution Maps - Present, 2010 and 2020 without Countermeasures

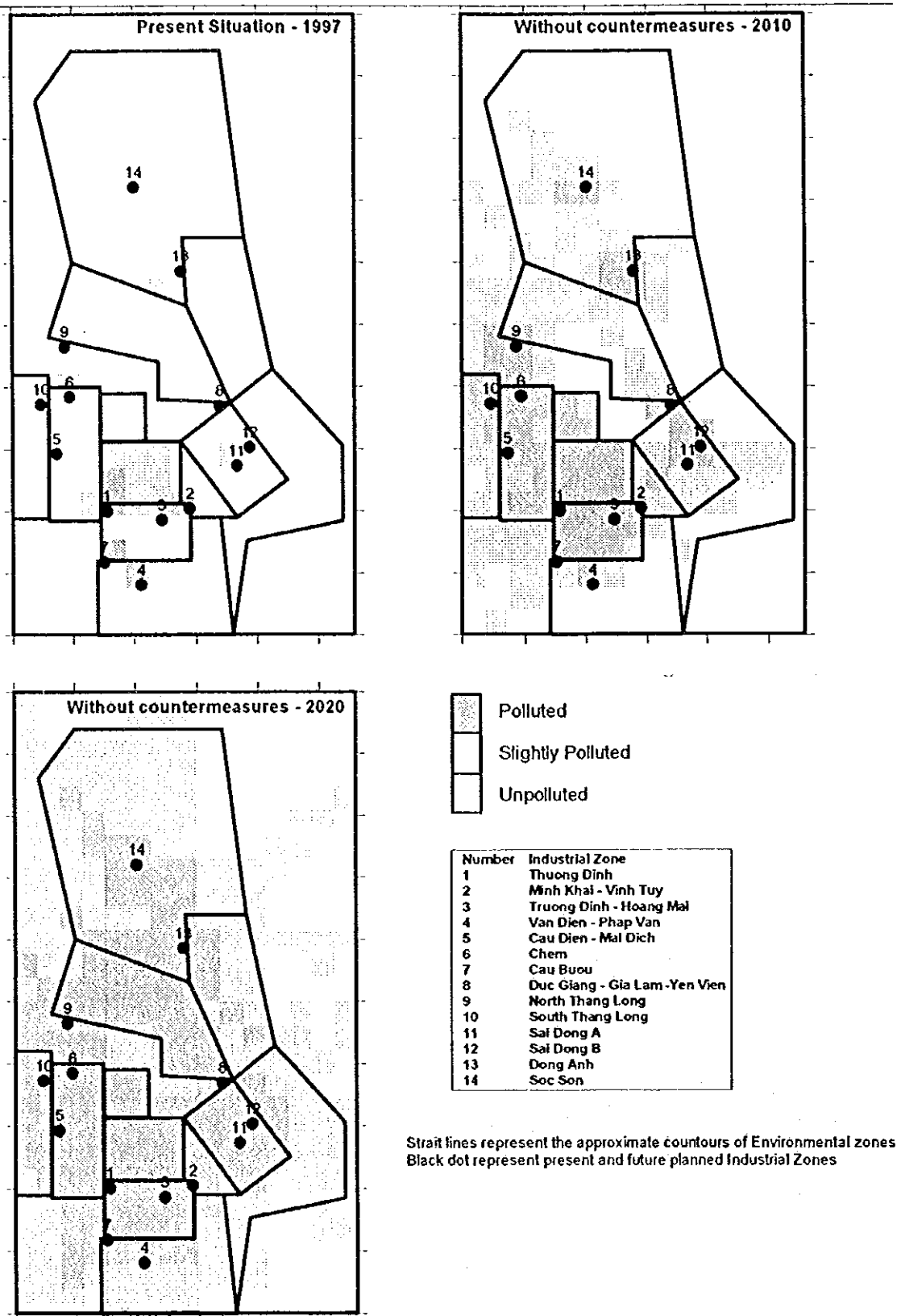


Figure 3.3.2 PM10 Air Pollution Maps - Present, 2010 and 2020 without Countermeasures

3.4 Expected Cleanliness of the City in the Future without Counter-measures

3.4.1 Freedom from Scattered Solid Waste

(1) Solid Waste

1) Measures Proposed

The main measures proposed by Study Team are:

- Increases in capacity and efficiency of waste collection and transport by a) development of waste transfer system, b) replacement of old equipment and construction of garages, and c) changing to direct collection with trucks,
- application of sanitary landfill at disposal site

(a) Situation Anticipated without the Measures for the Increases in Capacity and Efficiency of Waste Collection and Transport

The distance from the collection area to the new Nam Son landfill site is more than three times longer than the distance from the collection area to the previous landfill site in Tay Mo. Under this condition, if HPC does not implement the proposed measures a) and b) above, URENCO's capacity for regular collection and transport will decrease from 1,000 to/day to about 500 ton/day. If this condition continues, citizens' daily life will be affected in a few days. In one week or so, serious sanitary and hygienic problems will occur, and economic activities will be affected seriously.

For a few days in mid September 1999, URENCO was unable to collect and transport waste to either Nam Son landfill or Tay Mo landfill site due to opposition by local residents living near the two landfill sites. If this situation continued a few more days, it would have affected citizens' life seriously, and became a social and political problem. This incidence shows how important the regular waste collection is for the city.

If HPC do not implement the measure c) above (shifting to direct collection with trucks), HPC will lose opportunity of reducing costs of waste collection by at least 25%.

(b) Situation Anticipated without Application of the Proposed Sanitary Landfill

If HPC continues to practice open dumping, the following problems will occur:

- Deterioration of the environment of areas adjacent to the landfill sites due to leachate, smokes and fires, scattered waste, bad odor, insects that are

all generated on sites.

- HPC will have a serious difficulty in obtaining consent from local residents for construction of new landfill sites.
- Leachate may contaminate groundwater used as drinking water. (Groundwater contaminated by leachate generated from landfill sites may affect groundwater of urban areas due to flow of groundwater.)

3.4.2 Freedom from Scattered Nightsoil

(1) Measures proposed

The main measures proposed by the Study Team are:

- Temporary septage disposal ponds in Gia Lam to treat septage collected from Hanoi and Gia Lam
- Procurement of vehicles to improve collection capacity
- Regulations for mandatory cleaning of septic tanks
- Regulations and monitoring of collection and disposal activities
- Disconnection of septic tanks when public sewerage is developed

(2) Septage amounts without counter-measures

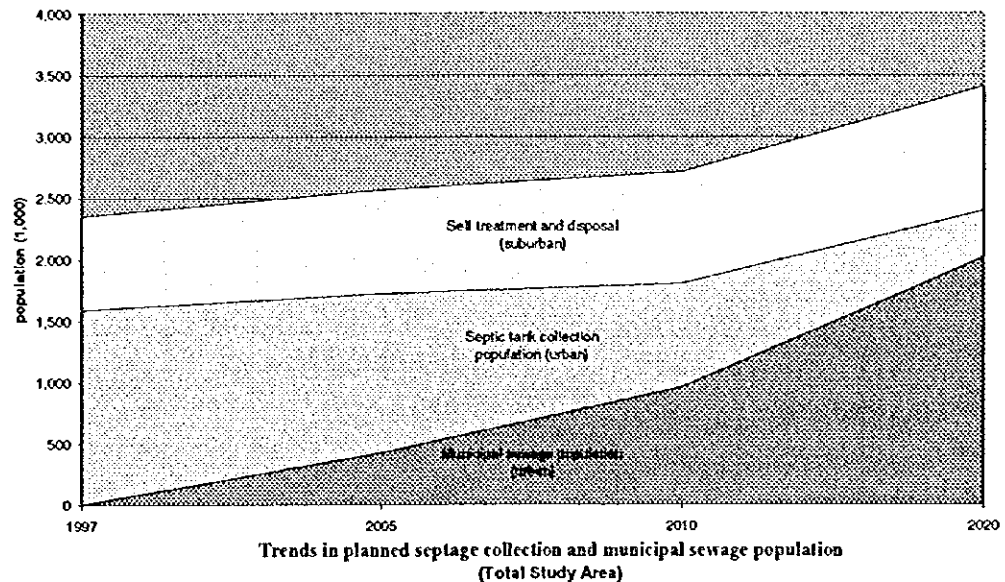
The majority of residential, commercial and institutional sanitation installations use septic tanks as a form of pre-treatment before discharging wastewater to drains. Septic tanks are currently maintained infrequently. Inadequate maintenance results in the accumulation and overflow of organic solids to drains thereby increasing pollutant loads on the environment.

URENCO presently collects septage at the request of owners and does not have sufficient capacity to collect septage from all the installations more frequently. Even if URENCO had the extra capacity, customers have no incentive to have their tanks cleaned and prefer to avoid paying for the cost of services until they absolutely need them. Also URENCO cannot collect more septage because it has no disposal and treatment facility. Septage collected by URENCO is now disposed of at Cau Dien composting facility. Composting is only effective in treating the solids in septage. Liquids that seep through the compost pile receive no treatment.

Private sector contractors are also actively involved in collection and disposal of septage. Their activities are completely unregulated and there is a public health concern because septage and raw human waste collected by private contractors is used to fertilize vegetables, feed fish and sometimes discharged indiscriminately.

As shown in the figure below, the number of people using septic tanks will remain relatively large even with the planned development of public sewerage. If collection

and disposal improvements are not implemented the role of the private sector will likely increase. In the absence of regulations governing their activities and appropriate enforcement, septage disposal will continue to have negative environmental and health impacts.



(3) Environmental conditions without improved septage management

If septage management is not improved, the organic load from septic tanks will increase in direct proportion to population growth. The situation will get worse if the implementation of sewerage systems is delayed or septic tanks are not taken out of service.

3.5 Expected Noise and Vibration Levels in the Future without Counter-measures

3.5.1 Traffic Predictions for 2010 and 2020

It is clear that noise and vibration mainly result from traffic congestion and factory activities. Vehicular traffic in Hanoi City is expected to continue to grow and to change in composition. The table below shows the expected changes in transportation estimated by the JICA Study Team based on the Master Plan for Urban Transport for Hanoi City (MPUT) prepared by JICA in 1997.

Expected Growth of Transportation in Hanoi City

	1995 MPUT	1997	2010	2015 MPUT	2020
Number of trips (%)					
	100	103	167	271	203
Kilometers traveled per year (%)					
Bicycle	100	98	76	141	66
Motorcycle	100	115	239	425	335
Car	100	117	431	1025	788
Bus	100	104	166	300	202
Truck	100	103	361	692	595
Total	100	107	174	315	230

Growth rates for the number of trips and distance travelled per year for 2015 estimated by MPUT are much higher than the JICA Study Team predicted for 2010 and 2020. The reason is that the JICA Study Team estimated these growth rates adopting a lower economic growth rate for the future than the one that MPUT used.

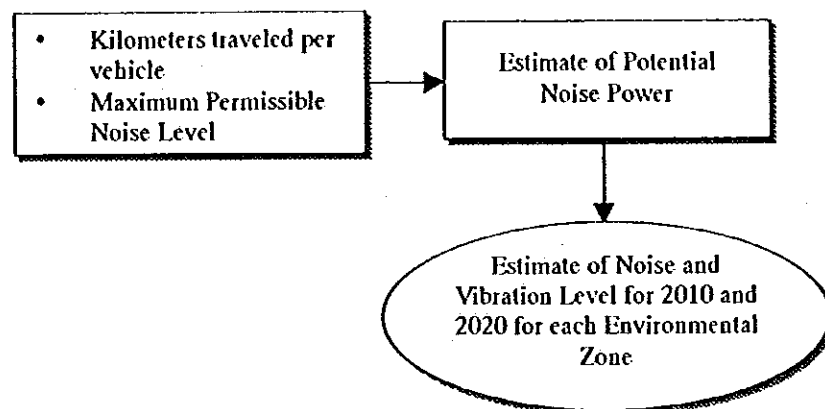
By 2020, the number of trips is expected to be more than double that in 1995. And also an increase in distances traveled will occur for the motorized vehicles such as motorcycles, cars, and trucks. Especially concerning cars, kilometers traveled are estimated to increase to about eight times that in 1995. Not only the sound of the engine, but also the noise of horns will contribute to the increase in noise. The noise level of old cars at 40 km/h is estimated at 97 dB, while the noise level of motorbikes at the same speed is estimated at 93 dB. It means that the noise of a car is equivalent to that of 2-3 motorbikes as shown in the expressions below.

$$10 \log (10^{93/10}) = 93 \text{ dB}$$

$$10 \log (2.5 * 10^{93/10}) = 97 \text{ dB}$$

3.5.2 Expected noise and vibration levels for 2010 and 2020 in the absence of counter-measures

The JICA Study Team estimated noise and vibration levels for 2010 and 2020 for each environmental zone without counter-measures based on the maximum permissible noise level, which is provided by Vietnamese law, kilometers traveled by vehicles, and current noise levels. The Study Team assumed that the vibration level is almost in direct proportion to the change of noise level, since both noise and vibration are closely related to motorized vehicles and the basic data for the estimate were obtained at roadsides. The flow of estimate is shown below. The estimated noise and vibration values are those only produced by motorized vehicles.



The flow of estimate of noise and vibration level

Potential noise power was estimated by multiplying kilometers traveled by coefficients, which were calculated based on maximum permissible noise level as shown in formulas below. In our forecast, all vehicles are considered to produce the noise equal to the maximum permissible level.

$$10 \log (10^{80/10}) = 80 \text{ dB}$$

$$10 \log (3.1 * 10^{80/10}) = 85 \text{ dB}$$

The adopted maximum permissible noise levels are shown in the following table. Permissible levels for cars and motorbikes with engines less than 125cc are the same. Buses and trucks, with weights of less than 3.5 tons, also have same permissible levels. There are looser permission noise levels for motorbikes with engines of more than 125cc and trucks whose weight is more than 3.5 tons. Therefore, estimated potential noise power is thought to show the lowest value assuming that each vehicle produces the noise same as the permissible level.

Noise Power Level for Each Type of Vehicle

Category of vehicles	Maximum permissible Noise Level (dB)	Coefficient
Motorcycle Cylinder capacity of Engine: not exceeding 125 cm ³	80	1
Car	80	1
Bus With more than 12 passengers	85	3.1
Truck Maximum weight: not exceeding 3.5 tons	85	3.1

Noise and vibration surveys were both conducted at five points. As these points did not correspond to the seven environmental zones which were proposed by the JICA Study Team, correspondence was assumed as shown in the table below. The data collected at Bach Mai were utilized to estimate the noise and vibration levels at Old City Center and Ho Tay Area, for example.

Correspondence of the Environmental Zones to the Survey Points

Environmental Zones	Type of Area	Correspondence to the Survey Points
1, Old City Center	Commercial area	Bach Mai
2, Red River Right Bank North- West	Residential area	Thuong Dinh
3, Red River Right Bank South	Industrial area	Thuong Dinh
4, Dong Anh urban area	Residential area	Dong Anh
5, Gia Lam urban area	Industrial area	Sai Dong
6, Sub-urban Area	Residential area	Soc Son
7, Ho Tay Area	Residential area	Bach Mai

The results of the estimate are shown in Table 3.5.1 – Table 3.5.3. At present, noise and vibration is not a serious problem in rural areas except noise pollution during the daytime. Until the year 2020, all the environmental zones are expected to remain polluted and the noise level will exceed 70 dB in five zones. With regard to the vibration level in years 2010 and 2020, all the zones are estimated to be polluted at night, while five will be polluted all day. In the Dong Anh urban area, where there is no vibration pollution at present, pollution will occur in 10 years.

Estimates of noise and vibration levels for 2010 and 2020 taken by the JICA Study Team are based on the distance traveled by vehicles. However, the sources of noise and vibration are not only traffic but commercial activities and factories. Therefore, noise and vibration pollution will be more serious than the estimated level without counter-measures. If no counter-measures are taken, the degree of pollution is expected to be even worse because of the rapid increase of motorized vehicles, especially in the urban area.

Table 3.5.1 Expected Noise and Vibration Level without Counter-measures

	Present	2010	2020
Running Kilometers (106km/y)			
Motorcycle	6,816	14,223	19,937
Car	103	379	693
Bus	144	231	281
Truck	340	1,189	1,959
Potential Noise Power (running kilometers * coefficient)			
Motorcycle (coefficient: 1.0)	6,816	14,223	19,937
Car (coefficient: 1.0)	103	379	693
Bus (coefficient: 3.1)	446	716	871
Truck (coefficient: 3.1)	1,054	3,686	6,073
Total Power (%)	100	226	328
Expected Noise Level (dB)			
1, Old City Center	69.1	72.6	74.3
2, Red River Right Bank North- West	68.9	72.4	74.1
3, Red River Right Bank South	68.9	72.4	74.1
4, Dong Anh urban area	62.6	66.1	67.8
5, Gia Lam urban area	67.7	71.2	72.9
6, Sub-urban Area	59.8	63.3	65.0
7, Ho Tay Area	69.1	72.6	74.3
Expected Vibration Level (dB)			
1, Old City Center	80.8	84.3	86.0
2, Red River Right Bank North- West	78.1	81.6	83.3
3, Red River Right Bank South	78.1	81.6	83.3
4, Dong Anh urban area	62.3	65.8	67.5
5, Gia Lam urban area	62.0	65.5	67.2
6, Sub-urban Area	58.7	62.2	63.9
7, Ho Tay Area	80.8	84.3	86.0

**Table 3.5.2 Noise Pollution for the Present, 2010 and 2020
without Counter-measures**

Environmental Zones		Present	2010	2020
1, Old City Center	Morning	P	P	P
	Daytime	P		
	Nighttime	P		
2, Red River Right Bank North- West	Morning	P	P	P
	Daytime	P		
	Nighttime	P		
3, Red River Right Bank South	Morning	P	P	P
	Daytime	P		
	Nighttime	P		
4, Dong Anh urban area	Morning	U	P	P
	Daytime	P		
	Nighttime	U		
5, Gia Lam urban area	Morning	P	P	P
	Daytime	P		
	Nighttime	U		
6, Sub-urban Area	Morning	P	P	P
	Daytime	P		
	Nighttime	U		
7, Ho Tay Area	Morning	P	P	P
	Daytime	P		
	Nighttime	P		

Note: P: Polluted U: Unpolluted

**Table 3.5.3 Vibration Pollution for the Present, 2010 and 2020
without Counter-measures**

Environmental Zones		Present	2010	2020
1, Old City Center	Daytime	P	P	P
	Nighttime	P		
2, Red River Right Bank North- West	Daytime	P	P	P
	Nighttime	P		
3, Red River Right Bank South	Daytime	P	P	P
	Nighttime	P		
4, Dong Anh urban area	Daytime	U	P	P
	Nighttime	U		
5, Gia Lam urban area	Daytime	U	SP	SP
	Nighttime	U		
6, Sub-urban Area	Daytime	U	SP	SP
	Nighttime	U		
7, Ho Tay Area	Daytime	P	P	P
	Nighttime	P		

Note: P: Polluted U: Unpolluted

SP: Slightly Polluted (Not being polluted whole day)

3.6 Expected Level of Co-existing with Nature and Provision of Amenity without Counter-measures

It is expected easily that the green and water zone will decrease drastically in the center of the city and the amenity facilities will be build here and there until the year of 2020 in case there are no counter-measures taken. The conditions of nature and amenity in Hanoi by each environmental zone are expected as shown in Table 3.6.1.

As described in the Table 3.6.1, the level of co-existing with nature and provision of amenity without counter-measures is expected as shown in the table below. Natural environment and amenity in almost all environmental zones will be deteriorated until 2020 without any countermeasures.

**Level of Co-existing with Nature and Amenity at Present,
2010 and 2020 without Counter-measures**

Environmental Zones	Present	2010	2020
1. Old City Center	B	C	C
2. Red River Right Bank North- West	B	B	C
3. Red River Right Bank South	B	B	C
4. Dong Anh urban area	B	B	C
5. Gia Lam urban area	B	B	C
6. Suburban Area	A	B	B
7. Ho Tay Area	B	C	C

Note: A: Fully satisfied, B: Partially satisfied, C: Not satisfied

**Table 3.6.1 Expected Conditions of Nature and Amenity up to 2020
without Counter-measures (1/2)**

Environmental Zones	Expected conditions of nature and amenity
1. Old City Center	This zone is in the center of Hanoi and characterized by condensed buildings, inhabitants and amenity facilities at present, with small. In this area, development will take precedence over co-existence with nature, and before 2010 it will be artificially areas with little green and water zone. Hoan Kiem Lake, which is the symbolic lake in Hanoi, is supposed to be smaller and polluted.
2. Red River Right Bank North- West	This zone locates in the western bank of Lich River and West Lake, and is mostly flat land used for agricultural purpose at this moment. By the year of 2020, the type of the land use will be gradually changed into commercial and residential use by the connection of Thang Long South highway to Hoa Lac highway and Route No.6, which are in this area.
3. Red River Right Bank South	The richness of water surface is the feature of this zone. Yen So Lake, which is one of the biggest lakes in Hanoi, is also in this zone. There is a possibility of the decrease of water area and the number of lakes, to meet the increase of the population in the future.
4. Dong Anh urban area	It is estimated in the Urban Master Plan for 2020 that nearly half of the land will be green/park and recreational use, and more than 1,600 ha will be industrial use. Residential use will not have high density in the zone. But the development of the industrial zone will have the priority over ensuring the recreational space without countermeasures.

Table 3.6.1 Expected Conditions of Nature and Amenity up to 2020 without Counter-measures (2/2)

Environmental Zones	Expected conditions of nature and amenity
5. Gia Lam urban area	This zone is characterized by industrial land use. Existing industrial area will be renovated by the introduction of the modern technology. By building the factory, quality of water will be worsened and natural area will also decrease before 2020.
6. Suburban Area	The total area of this zone reaches 657 km ² and the population is estimated to be almost 1 million in 2020. Most of the area will be agricultural land, while gradual renovation and economic improvement will be done by ways of non-agricultural activities in this zone. The land use type could be maintained with small change. Nature area, such as water and green zone will not change so much but small decrease will happen because of the increase of population.
7. Ho Tay Area	Ho Tay lake (West Lake) lies within the Ho Tay district which is adjacent to the Old City Center. The spacious water surface together with long waterfront fringed with green attracts residents as visitors, both Vietnamese and foreign. However, the shore of the lake has been reclaimed for residential and commercial purposes and raw sewage is being discharged into the lake. As a consequence, the water surface has been reduced continuously these years and the quality of water as well as the bottom material has been deteriorated. Although this area is planned as recreational center with friendly water and green to prove amenity to the Hanoi citizens as well as for visitors, this zone would seriously be polluted and unable to play its role as recreational center, if effective counter-measures are not taken.

3.7 Expected Level of Preserving Cultural and Historical Assets without Counter-measures

Many of the cultural assets and historical assets are located in Old City Center and Ho Tay Area, therefore, the JICA Study Team has limited the estimation of future conditions of assets to these two environmental zones as shown in Table 3.7.1.

As described in Table 3.7.1, the level of the preservation of cultural and historical assets is expected as shown below. By 2010, the level is projected to be "Not Satisfied" for two environmental zones.

**Level of Preserving Cultural and Historical Assets
at Present, 2010 and 2020 without Counter-measures**

Environmental Zones	Present	2010	2020
1. Old City Center	B	C	C
2. Red River Right Bank North- West	-	-	-
3. Red River Right Bank South	-	-	-
4. Dong Anh urban area	-	-	-
5. Gia Lam urban area	-	-	-
6. Suburban Area	-	-	-
7. Ho Tay Area	B	C	C

Note: A: Fully satisfied, B: Partially satisfied, C: Not satisfied

**Table 3.7.1 Expected Conditions of Cultural and Historical Assets
up to 2020 without Counter-measures**

Environmental Zones	Expected Conditions of Cultural and Historical Assets
1. Old City Center	<p>The Ancient Quarter is the densely built-up area and typical historical relic in Hanoi City. Though the area is valuable as a relic, many of the buildings in the Quarter are over age for people to live and sanitary environment is not satisfactory one.</p> <p>The Ancient Quarter will not be preserved any more and modern high buildings or shop will replace without counter measures. Even at present, there are some buildings, which do not suit the old cultural streets much because of their showy color of the walls or windows, modern shape and outstanding height, are constructed very close to the center of the Ancient Quarter.</p> <p>There are precious pagodas (Den Ngoc Son), museums (Military Museum, History Museum etc.) and architectures, some of them are relics of the colonial periods and used daily now (Opera House, Long Bien Bridge, Nha Tho Lon), in this area. If nothing will be taken for preserving them, we would not be able to use these precious architectures any more, and the conditions of pagodas and exhibitions in the museums would be terrible by the year of 2010.</p>
7. Ho Tay Area	<p>There are precious pagodas, some of them are built almost 1000 years ago (Van Mieu, Chua Mot Cot). They need to be maintained carefully, and if nothing will be taken for preserving them, the level of preservation will be "not satisfied" by the year of 2010.</p> <p>The facilities in Ho Chi Minh Mausoleum will be out of date in 2010 and it will be hard to keep the remain of Uncle Ho safely.</p> <p>There are old French-style houses and buildings getting together, which area is one of the historical relics, around Ho Chi Minh Mausoleum. There are possibilities for them to be rebuilt to modern-style houses or buildings without development regulations.</p>

Chapter 4 Zoning of the Hanoi City for Effective Environmental Management

4.1 Environmental Zoning

4.1.1 Objectives of Environmental Zoning

Environmental zoning is a tool for effective management of the environment in order to achieve the set targets of the environmental improvement and management of the Hanoi city in line with the environmental principles. Within each environmental zone, same level of environmental quality should be sought. Each zone has peculiar characteristics in terms of land use, population density, industrial structure and others and can be recognized as one unit of area with similar characteristics.

4.1.2 Criteria for Establishing Environmental Zones

With a view to carrying out effective management of the environment, environmental zones are established based on the following criteria.

- a) Current and future land use pattern and intensity
- b) Current conditions of the environmental pollution and danger of future degradation
- c) Physical continuity of natural environment
- d) Administrative boundaries

(1) Land Use

Similarity of land use pattern, intensity and population density requires similar characteristics and level of environmental quality and should be a principle factor for determining environmental zoning. Besides the current land use, the expected land use and socioeconomic characteristics stated in the Hanoi Urban Master Plan for 2020 which has been approved by the Prime Minister of the Government, are referred to as future perspective of the city.

(2) Current Conditions and Future Danger of Environmental Pollution

Currently, environmental pollution is significant or even serious in some areas of the currently urbanized area in the seven urban districts and eastern part of Tu Liem district and northern part of Thanh Tri district in terms of water pollution. For these areas, quick actions are needed from the viewpoint of improving the already deteriorated environment, including the implementation of environmental infrastructures, strengthening of enforcement of environmental laws and

regulations, etc.

In the Hanoi Urban Master Plan for 2020, rapid urbanization is envisaged, by which urbanized area will be about tripled, from the current 84 km² to 245 km² comprising 37 urban units. Notably, urbanization will be expanded to the north across the Red River. In the newly urbanized areas, pollution load generation and discharge will quickly be increased and without effective environmental management, the current good environment will rapidly be degraded. In these areas to be urbanized in the coming years where currently environmental pollution is not significant, prevention of the expected danger of environmental deterioration should be the principle stance for the environmental management.

After the year 2020, majority of the land of about 70% in the city will remain rural with major land use of agriculture and nature-oriented land use of forest, green and water surface. Currently, pollution is negligible in these areas and conservation of the nature should be the stance for the environmental management.

These difference in the current pollution levels and future danger of environmental deterioration should also be taken into account.

(3) Physical continuity of natural environment

Discharged pollutants of effluents, exhaust gas, noise and others, will reach receiving bodies of water, air, and earth. These bodies are partly continuous and partly discontinued or confined. The received pollutants flow according the natural divisions including water and air regimes, being affected by climatic and flow conditions. In the case of Hanoi, river catchment areas should be of major concern, considering that water pollution in the urban rivers are the most serious.

(4) Administrative boundaries

Administrative boundaries and units should be considered for establishing appropriated environmental zones for the effective administrative management and efficient provision of public services as follows.

- a) Effective environmental planning and implementation
- b) Effective conduct of monitoring, inspection and law enforcement
- c) Implementation of public undertaking for environmental improvement and efficient operation and maintenance thereof
- d) Efficient provision of public services including solid waste collection, septage collection and sewerage service

In the case of the Hanoi city, there are three major administrative levels, i.e., city,

district and subdistrict (precincts in the case of urban district). Major responsibilities of the administrative works within the city lie in the City Government and a little is delegated to the lower levels. Execution and management of environmental services are provided across the district boundaries by executing bodies. In the case of solid waste collection, URENCO covers the major portion of the seven urban districts, while environmental companies are providing services by district outside the urban districts. Hanoi Sewerage and Drainage Company has the responsibility for the operation and maintenance of sewerage and drainage facility installed in the city. In the case of the Hanoi city where wide area administration is in practice, therefore, city boundary is the major concern for the consideration of the environmental zoning.

4.1.3 Adopted Environmental Zones

Based on the this criteria, seven environmental zones are adopted in the JICA study. Red river is flowing down through the city from north-west to south-east with about 17.2 km² of area, significantly affecting the water environment of the city. However, the river is a inter-provincial as well as international river and full control of the river is beyond the jurisdiction of Hanoi City. Red river area is, therefore, designated as a quasi zone for which only desirous environmental targets will be set and no concrete measures for environmental improvement will be formulated in this Study, except monitoring system. The established environmental zones are summarized below and illustrated in Figure 4.1.1.

Established Environmental Zones

Zone No.	Name	Area (km ²)	Population in 2020 (persons)
1	Old City Center	35.0	800,000
2	Red River Right Bank North-West	55.9	383,000
3	Red River Right Bank South	27.0	285,000
4	Dong Anh urban area	85.3	672,000
5	Gia Lam urban area	43.0	328,000
6	Suburban area	657.6	1,007,922
7	Ho Tay area	4.1	32,000
	Total	907.9	3,507,922
8	Red river quasi zone	19.6	-

4.2 Future Prospects of Environmental Zones

Desirous prospects for the city and each zone from the viewpoint of environment are worked out as given.

(1) Hanoi City

Hanoi City as a whole has dual faces in various senses at present and in the future as well. The city has the old quarters developed since French period with orderly streets and classy buildings together with the nature of green and trees and lakes, located in the northeastern part of the existing urbanized area, mainly Hoan Kiem district and a part of Ba Dinh district. New urban areas will be built both on the right bank of the Red river in Tu Liem and Thanh Tri districts as well as on the left bank in Don Anh and Gia Lam districts. Currently, urbanized area accounts only for less than 10% of the 927 km² of the city area. There remains vast rural areas. At present, nature-oriented land use comprising agricultural land, forest and green and water surface, accounts for about three-fourths of the whole area. In the year 2020, 70% of the land is still planned to be used under these categories.

From environmental viewpoint, adequate natural environment should be reserved in parallel with the strengthening of the urban function of the city as the state capital for public administration, economic development, and cultural development. Namely, future prospects of Hanoi City toward 2020 should be "Modern City with Country Scenery". To be specific, the prospects should be as follows.

1) Safe and healthy life

Safe and healthy environment will be maintained for the Hanoi citizens, preventing public nuisance.

2) Human living environment for the future generation

Human environment where nature with green and water and man-made structures with modern streets and landscaping and cultural and historical assets will be co-existing, will be created for the future generation.

3) Comfortable and convenient urban environment

Urban environment with well-developed urban infrastructures which assures comfortable and convenient urban life for the citizens, assuring short commuting time between living and working places, will be created.

(2) Environmental zones

Future prospects of the socioeconomic development and land use of the established

environmental zones comprising seven zones and one quasi zone from the environmental viewpoint, are given below. The details are given from Table 4.2.1 through Table 4.2.15. Environmental zoning is illustrated in Figure 4.1.1.

Environmental Zones

Zone No.	Name	Environmental Prospects
1	Old City Center	Zone with cultural and historical heritage
2	Red River Right Bank North-West	International city with comfortable space
3	Red River Right Bank South	Gateway zone with clean industries
4	Dong Anh urban area	Super eco-city
5	Gia Lam urban area	New industrial city
6	Suburban area	Fresh sub-urban zone with gentle nature
7	Ho Tay area	Waterfront amenity zone
8	Red river quasi zone	Motherly romantic river front

Table 4.2.1 Future Prospects for Environmental Zone 1: Old City Center (1/2)

1. Old City Center (Mainly consists of Ba Dinh, Hoan Kiem, Hai Ba Trung, Dong Da Districts)		Location						
<div><div><div>1.1 Environmental Prospects : "Classy Zone of Hanoi as Heritage"</div><div>1.2 Characteristics</div><div><p>This area is from the 2nd ring inwards to the center and mainly consist of Ba Dinh, Dong Da, Hoan Kiem, and Hai Ba Trung and a part of (3 subdistricts of) Tay Ho district. This is a spread of fine old towns and is the actual political, governmental, economic, and educational center not only of Hanoi but also of this country. However it has many narrow streets and congested buildings, poor infrastructures. Urban Master Plan 2020 definitely indicates this area as "Restricted Development Area". According to the unique concept of this plan, the environmental zoning must follow this direction.</p><div>1.3 Land Use and Urban Functions</div><div>1) Land use</div><div><p>This zone is characterized by condensed buildings and inhabitants, traffic congestion (mostly by motorcycles) at present, where is Hanoi's central area. Most of land is used for governmental services, commercial & business activities mixed with residential rooms, education, various small industries producing foods, metal goods, furniture, miscellaneous manufacturing, recreation/park, etc., and some streets are occupied by street vendors. All of such phenomena form lively urban atmosphere of current Hanoi.</p><p>In the Urban Master Plan 2020 states that the population of the area should be decreased by resettlement into other development area or natural decrease, and the development within the area should be strictly restricted. In this context, land use of the zone will not be changed basically from now until 2020.</p><p>This area has memorized many and great national history, which really is the national museum as a whole. Thus, needless to mention of physical environment improvement, the historical environment for national dignity should be highlighted in the zone. Through this way, its flavor will be deepened towards a classy zone.</p></div><div>2) Urbanization forecast</div></div></div><div><table><tr><th>1997</th><th>2010</th><th>2020</th></tr><tr><td>Center of any activities in Hanoi, and high population density are forming characteristics of the zone.</td><td>Population will be decreased by guided resettlement.</td><td>The concept will be realized and a calm, classy and elegant city with dignity will give peaceful atmosphere to the people.</td></tr></table></div></div> <div></div>		1997	2010	2020	Center of any activities in Hanoi, and high population density are forming characteristics of the zone.	Population will be decreased by guided resettlement.	The concept will be realized and a calm, classy and elegant city with dignity will give peaceful atmosphere to the people.	
1997	2010	2020						
Center of any activities in Hanoi, and high population density are forming characteristics of the zone.	Population will be decreased by guided resettlement.	The concept will be realized and a calm, classy and elegant city with dignity will give peaceful atmosphere to the people.						

Table 4.2.2 Future Prospects for Environmental Zone 1: Old City Center (2/2)

1.4 Related Urban Units							
Unit	Area	Districts			1997	2010	2020
01	100	Hoan Kiem	Population	(person)	67,380	51,645	50,000
			pop. Density	(person/ha)	674	516	500
02	102	Hoan Kiem	Population	(person)	25,797	25,822	25,000
			pop. Density	(person/ha)	253	253	245
03	163	Hoan Kiem	Population	(person)	50,980	36,151	35,000
			pop. Density	(person/ha)	313	222	215
04	319	Hai Ba Trung	Population	(person)	105,313	92,961	90,000
			pop. Density	(person/ha)	330	291	282
05	449	Hai Ba Trung	Population	(person)	116,398	108,454	105,000
			pop. Density	(person/ha)	259	242	234
06	140	Ba Dinh	Population	(person)	24,144	17,559	17,000
			pop. Density	(person/ha)	172	125	121
07	109	Ba Dinh	Population	(person)	24,258	25,822	25,000
			pop. Density	(person/ha)	223	237	229
08	347	Ba Dinh	Population	(person)	48,952	70,237	68,000
			pop. Density	(person/ha)	141	202	196
09	456	Hoan Kiem	Population	(person)	82,510	82,632	80,000
			pop. Density	(person/ha)	181	181	175
010	297	Hoan Kiem	Population	(person)	116,253	98,125	95,000
			pop. Density	(person/ha)	391	330	320
011	534	Hai Ba Trung	Population	(person)	138,103	130,145	126,000
			pop. Density	(person/ha)	259	244	236
012	178	Hai Ba Trung	Population	(person)	53,332	35,119	34,000
			pop. Density	(person/ha)	300	197	191
014	305	Ba Dinh	Population	(person)	68,624	51,645	50,000
			pop. Density	(person/ha)	225	169	164
Total	3,499		Population	(person)	922,044	826,317	800,000
			pop. Density	(person/ha)	264	236	229

Table 4.2.3 Future Prospects for Environmental Zone 2: Red River Right Bank – North West (1/2)

2. Red River Right Bank - North West (Mainly consists of Cau Giay and Tu Liem Districts)	Location						
<p>2.1 Environmental Prospects : "International City of Hanoi with Comfortable Space"</p> <p>2.2 Characteristics</p> <p>This zone is situated northwest of Red river right bank including Nam Thang Long IZ, Dien IZ, Xuan La Trade and Finance Center, Nghia Do Scientific Center and Nghia Do Urban area, Diplomatic Corps area, Ciputra new urban area (Transaction City), Thang Long International Village. In the more southern part of the zone will be Thong Dinh-Nguyen Trai IZs, National Sports Center, My Dinh entertainment area (Me Tri City), Trung Yen, Yen Hoa, Thanh Xuan Bac, Thanh Xuan Nam new urban area.</p> <p>This zone will be developed as an international city with large space for trade, diplomatic corps, and new urban area.</p> <p>2.3 Land Use and Urban Functions</p> <p>1) Land use</p> <p>This zone locates in the western bank of Lich River and West Lake, and is mostly flat land used for agricultural purpose at this moment. By the year of 2020, the land use will be drastically changed. Besides existing industrial use, land will be applied for public use (including commercial and business), residential use, and green/recreation use. The far west part of the zone will be industrial use and R&D use. A skeleton of road network will be grids and wide. Existing Thang Long South Highway will be connected to Hoa Lac Highway and Route No.6 in this zone.</p> <p>From an urban aspect, this zone's function will be to take a role of new business center of Hanoi which will produce intangible value as well as to provide a first-class residential area and recreation space to the citizens.</p> <p>2) Urbanization forecast</p>							
<table><tr><th>1997</th><th>2010</th><th>2020</th></tr><tr><td>Not yet developed and some small conglomeration of shops with residences existing along trunk roads.</td><td>Rather rapid urban development will be realized among Thang Long Highway to West Lake.</td><td>Planned urban conglomerations will be fully realized.</td></tr></table>	1997	2010	2020	Not yet developed and some small conglomeration of shops with residences existing along trunk roads.	Rather rapid urban development will be realized among Thang Long Highway to West Lake.	Planned urban conglomerations will be fully realized.	
1997	2010	2020					
Not yet developed and some small conglomeration of shops with residences existing along trunk roads.	Rather rapid urban development will be realized among Thang Long Highway to West Lake.	Planned urban conglomerations will be fully realized.					

Table 4.2.4 Future Prospects for Environmental Zone 2: Red River Right Bank – North West (2/2)

2.4 Related Urban Units									
Unit	Area	Districts				1997	2010	2020	
015	1,265	Tay Ho Tu Liem	Population		(person)	44,193	73,773	85,000	
			pop. Density		(person/ha)	35	58	67	
016	680	Tu Liem	Population		(person)	15,936	47,736	55,000	
			pop. Density		(person/ha)	23	70	81	
017	620	Cau Giay	Population		(person)	62,986	65,094	75,000	
			pop. Density		(person/ha)	102	105	121	
018	900	Cau Giay Tu Liem	Population		(person)	41,566	35,585	41,000	
			pop. Density		(person/ha)	46	40	46	
019	645	Thanh Xuan Cau Giay	Population		(person)	51,985	60,754	70,000	
			pop. Density		(person/ha)	81	94	109	
020	745	Thanh Xuan Tu Liem	Population		(person)	31,831	36,453	42,000	
			pop. Density		(person/ha)	43	49	56	
024	735	Tu Liem	Population		(person)	15,332	13,019	15,000	
			pop. Density		(person/ha)	21	18	20	
Total	5,590		Population		(person)	263,829	332,414	383,000	
			pop. Density		(person/ha)	47	59	69	

Note: Due to the disagreement of the boundaries of urban units and subdistricts for certain cases, present population of some urban units and these for 2010 estimated by the Study Team may not be accurate subject to revision during the second study in Vietnam.

Table 4.2.5 Future Prospects for Environmental Zone 3: Red River Right Bank – South (1/2)

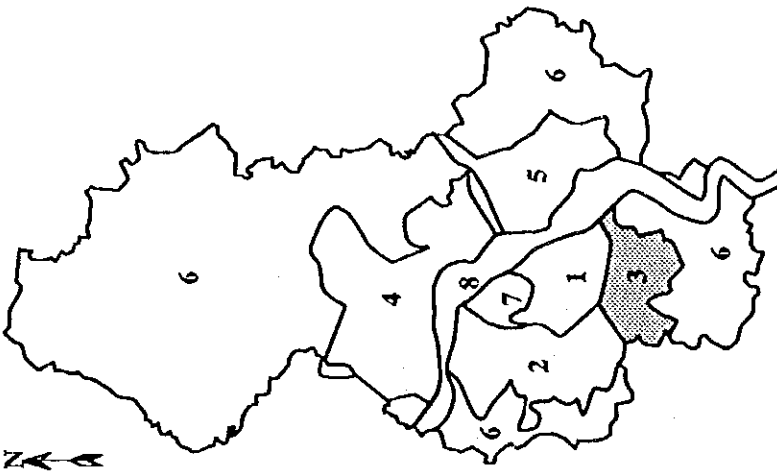
3. Red River Right Bank - South (Mainly consists of Thanh Xuan and Thanh Tri Districts)	Location
<p>3.1 Environmental Prospects : "Gate Way Zone of Hanoi with Clean Industries"</p> <p>3.2 Characteristics</p> <p>This zone is situated southeast of Red River Right Bank including the Phap Van-Cau Bieu-Van Dien IZ, Dien IZs group, Minh Khai-Vinh Tuy IZs as well. New conglomeration will have place along Route No.1 and Dinh Cong, Dai Kim, Linh Dam, and Yen So tourist service area.</p> <p>The zone will be developed as industrial city with rich green and abundant water space.</p> <p>3.3 Land Use and Urban Functions</p> <p>1) Land use</p> <p>This zone having 27 km² and spreading along both the eastern and western sides of Route No.1 is relatively small among the eight environmental zoning objects. Today and in future the zone steadily is to be the gateway from southern parts of this country including Ho Chi Minh. Therefore the tourist service area is planned here. Land use in the zone will be gradually changed for the future, but it will not be a big change. Land will be used for newly sited industries, urban housing, and water-intimated recreational places which utilize rich water surfaces in the zone. In the Urban Master Plan 2020 a lot of reserved area (including governmental reserve) are allocated here to prevent from polluting water resources.</p> <p>From an urban aspect, this zone's function will be to take a role of something abstemious against rapid urbanization, and to provide an atmosphere of "rural in urban" to ordinary people. Particularly to preserve huge water surfaces as a multi-resource, this direction of land use is quite important.</p> <p>2) Urbanization forecast</p>	
<p>Not yet developed and some small conglomeration of shops with residences exist along trunk roads.</p>	<p>Planned urban conglomeration will be fully realized.</p>

Table 4.2.6 Future Prospects for Environmental Zone 3: Red River Right Bank – South (2/2)

3.4 Related Urban Units							
Unit	Area	Districts			1997	2010	2020
021	1,075	Thanh Xuan	Population	(person)	103,298	108,490	125,000
		Thanh Tri	pop. Density	(person/ha)	96	101	116
022	400	Thanh Tri	Population	(person)	18,291	21,698	25,000
		Thanh Xuan	pop. Density	(person/ha)	46	54	63
023	1,220	Hai Ba Trung	Population	(person)	136,069	117,169	135,000
		Thanh Tri	pop. Density	(person/ha)	112	96	111
Total	2,695		Population	(person)	257,658	247,357	285,000
			pop. Density	(person/ha)	96	92	106

Note: Due to the disagreement of the boundaries of urban units and subdistricts for certain cases, present population of some urban units and those for 2010 estimated by the Study Team may not be accurate subject to revision during the second study in Vietnam.

Table 4.2.7 Future Prospects for Environmental Zone 4: Dong Anh Urban Area (1/2)

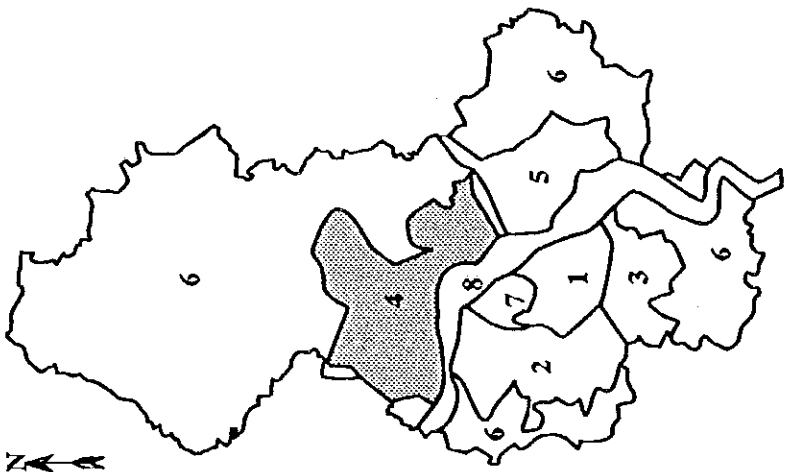
4. Dong Anh (Consists of Dong Anh Districts)	Location
<p>4.1 Environmental Prospects : "Super Eco-City"</p> <p>4.2 Characteristics</p> <p>This zone is situated north of Thang Long Bridge and surrounding Van Tri Lake, also north along with Red River, having the area of 8,525 ha. North Thang Long will have IZ and huge sports facilities. Dong Anh town will grow up based on Dong Anh IZ which will provide services, trade and finance function. In Vuc De, Tam Xa tourism and recreational projects will be executed.</p> <p>Co Loa area with the ancient citadel and relies as the center for trade, service, culture and sports activities will extend along Red River and Duong River. The zone will be developed as a completely modern city of Hanoi.</p> <p>4.3 Land Use and Urban Functions</p> <p>1) Land use</p> <p>This zone has more than 85 km² of area, 2.4 times bigger than the Old City Center zone. A huge scale of urban planning is applied here for the present agricultural fields. Each lot or development block is also broad, which characterize this zone as a whole.</p> <p>Nearly half of the land will be green/park and recreational use, more than 1,600 ha to be industrial use, public use (including commercial & business) also will be large scale with some 700 ha. Residential use will not have high density by dispersing allocation in the zone.</p> <p>As an urban function new and economically autonomous function is expected for the zone, to mobilize foreign investment, to produce hi-tech industrial goods, and to provide ideal urban space to the people.</p> <p>2) Urbanization forecast</p>	
<p>Not yet developed and some small conglomeration of rural residence exist. Recently wave of urbanization is coming at Kim No, Mai Lam.</p>	<p>1997</p> <p>2010</p> <p>2020</p> <p>Planned urban facilities will be fully devaluation of existing rural residence.</p>

Table 4.2.8 Future Prospects for Environmental Zone 4: Dong Anh Urban Area (2/2)

4.4 Related Urban Units							
Unit	Area	Districts			1997	2010	2020
030	930	Dong Anh	Population	(person)	10,414	14,035	30,000
			pop. Density	(person/ha)	11	15	32
031	1,180	Dong Anh	Population	(person)	17,236	50,527	108,000
			pop. Density	(person/ha)	32	43	92
032	1,190	Dong Anh	Population	(person)	14,679	45,849	98,000
			pop. Density	(person/ha)	12	39	82
033	550	Dong Anh	Population	(person)	5,058	35,088	75,000
			pop. Density	(person/ha)	9	64	136
034	1,450	Dong Anh	Population	(person)	14,802	45,849	98,000
			pop. Density	(person/ha)	10	32	68
035	660	Dong Anh	Population	(person)	6,827	35,088	75,000
			pop. Density	(person/ha)	10	53	114
036	1,135	Dong Anh	Population	(person)	8,539	38,831	83,000
			pop. Density	(person/ha)	8	34	73
037	1,430	Dong Anh	Population	(person)	36,362	49,123	105,000
			pop. Density	(person/ha)	25	34	73
Total	8,525		Population	(person)	113,917	314,390	672,000
			pop. Density	(person/ha)	16	37	79

Table 4.2.9 Future Prospects for Environmental Zone 5: Gia Lam Urban Area (1/2)

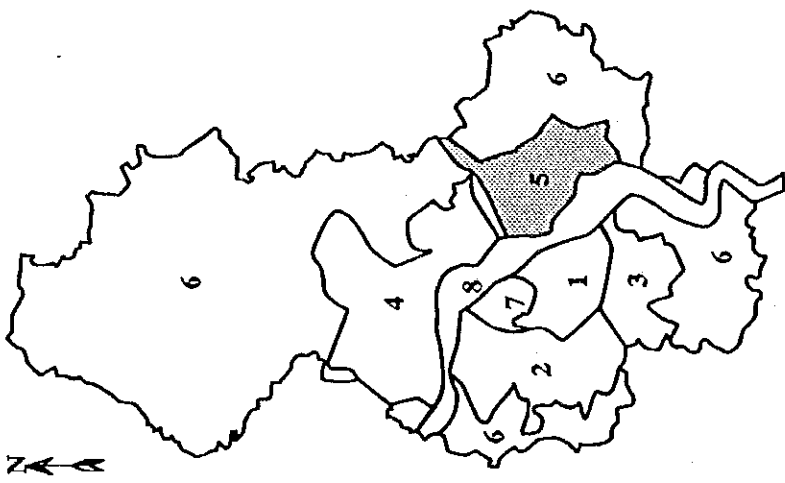
5. Gia Lam (Consists of Gia Lam Districts)		Location						
<p>5.1 Environmental Prospects : "New Industrial City"</p> <p>5.2 Characteristics</p> <p>Gia Lam - Sai Dong - Yen Vien area will be established based on large and concentrated IZs such as Sai Dong A & B, Duc Giang IZ, Gia Lam, Cau Duong Trade and Service Center, etc.</p> <p>This zone will be a huge industrial zone located in just the southern parts of Duong River. Existing industrial area will be renovated as a modern one together with new development.</p> <p>5.3 Land Use and Urban Functions</p> <p>1) Land use</p> <p>This zone has almost 43 km² of area having already urbanized a block along Route No.1, No.5, and Red River. Therefore, future development will be expanded along Duong River, and Outer Ring Road with huge industrial land use and green/park use respectively. There will be lot of buffer land to avoid flood influence by Red River and Duong River. Also the zone will have the same nature of the Zone-3 which is expected counter area against rapid chaotic urbanization. For that purpose, the Master Plan prepares a quantity of reserved land in this zone.</p> <p>Existing industrial activities provide oil-related production, electronics production, and vendor commerce, which will be continued for a long time more because supply demand by suburban small scale industries or rural consumers. Meanwhile newly coming industries will have rather mass-production oriented activity which will support not only rural needs but also urban and northern regions' needs of this country.</p> <p>2) Urbanization forecast</p>								
<p>Urbanization has grown along Route No.1 and No.5 and rapidly extended even to southeastern outside of Hanoi.</p>		<table><tr><th>1997</th><th>2010</th><th>2020</th></tr><tr><td>Urbanization has grown along Route No.1 and No.5 and rapidly extended even to southeastern outside of Hanoi.</td><td>Urbanization will be rapidly realized by industrial investment.</td><td>Planned urban facilities will be fully developed.</td></tr></table>	1997	2010	2020	Urbanization has grown along Route No.1 and No.5 and rapidly extended even to southeastern outside of Hanoi.	Urbanization will be rapidly realized by industrial investment.	Planned urban facilities will be fully developed.
1997	2010	2020						
Urbanization has grown along Route No.1 and No.5 and rapidly extended even to southeastern outside of Hanoi.	Urbanization will be rapidly realized by industrial investment.	Planned urban facilities will be fully developed.						

Table 4.2.10 Future Prospects for Environmental Zone 5: Gia Lam Urban Area (2/2)

5.4 Related Urban Units									
Unit	Area	Districts				1997	2010	2020	
025	990	Gia Lam	Population	(person)		62,262	55,673	119,000	
			pop. Density	(person/ha)		63	56	120	
026	1,475	Gia Lam	Population	(person)		30,169	48,188	103,000	
			pop. Density	(person/ha)		20	33	70	
027	780	Gia Lam	Population	(person)		16,920	36,492	78,000	
			pop. Density	(person/ha)		22	47	100	
028	850	Gia Lam	Population	(person)		9,508	5,146	11,000	
			pop. Density	(person/ha)		11	6	13	
029	200	Gia Lam	Population	(person)		10,531	7,953	17,000	
			pop. Density	(person/ha)		53	40	85	
Total	4,295		Population	(person)		129,390	153,452	328,000	
			pop. Density	(person/ha)		30	36	76	

Note: Due to the disagreement of the boundaries of urban units and subdistricts for certain cases, present population of some urban units and these for 2010 estimated by the Study Team may not be accurate subject to revision during the second study in Vietnam.

Table 4.2.11 Future Prospects for Environmental Zone 6: Sub-Urban Area (1/2)

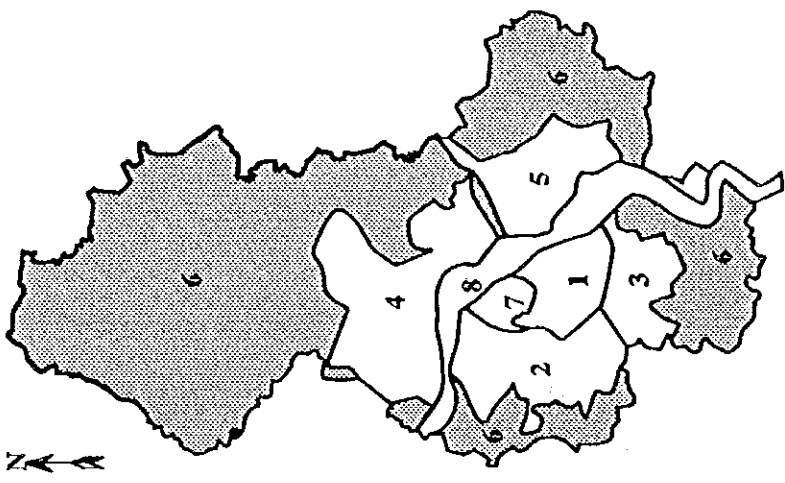
6. Rural Area (Consists of Soc Son, Dong Anh, Gia Lam, Thanh Tri, and Tu Liem Districts)	Location
<p>6.1 Environmental Prospects : "Fresh Suburban Zone with Gentle Nature"</p> <p>6.2 Characteristics</p> <p>This zone shall be divided into three suburban direction, namely Soc Son, and Dong Anh suburbs, Gia Lam suburban, and Red River Right Bank suburbs.</p> <p>However, Soc Son will have urban conglomeration as a service center for Noi Bai airport. Gia Lam suburban district also will be semi-urbanized area by 2020 as the industrial investment will increase. Southern part of Thanh Tri District will be urbanized gradually even it is positioned out of the Urban Plan 2020 for Hanoi. While western part of Tu Liem District will remain much suburban area.</p> <p>In this zone gradual renovation and economic improvement will be done by ways of non-agricultural activities. Small scale industry will be introduced by inhabitants for their income generation.</p> <p>6.3 Land Use and Urban Functions</p> <p>1) Land use</p> <p>This zone is excluded from Hanoi Central City (37 urban planning units) in the Urban Master Plan 2020. But its total area reaches 657 km² (2.6 times larger than 37 urban planning units) having 1 million population in 2020. Most of land will be still used for agriculture (including horticulture and livestock breeding), partly for urban use, recreational use, forestry use, etc. In Soc Son District there are Noi Bai international airport having runways of east-west direction under expansion work of the terminal buildings. The airport occupies more than 1,000 ha of land. These land use could be maintained with small change.</p> <p>Function of this zone is expected as supply source of fresh vegetables, fruits, flesh, eggs, milk, and grains for the capital city. Moreover it should provide clean and natural resources for people's relaxation.</p> <p>2) Urbanization forecast</p>	
<p>Most of the area of the zone is agriculture land. There are some rural towns in Soc Son, Thanh Tri, and Tu Liem.</p>	<p>Urbanization will give some effect to the zone.</p>
<p>There will be some urbanized conglomerations in these areas by 2020.</p>	

Table 4.2.12 Future Prospects for Environmental Zone 6: Sub-Urban Area (2/2)

6.4 Related Urban Districts						
District	Area			1997	2010	2020
Tu Liem	3,786	Population	(person)	70,438	80,787	86,623
		pop. Density	(person/ha)	19	21	23
Thanh Tri	7,989	Population	(person)	154,898	188,942	217,338
		pop. Density	(person/ha)	19	24	27
Gia Lam	12,382	Population	(person)	183,420	214,463	235,730
		pop. Density	(person/ha)	15	17	19
Dong Anh	9,310	Population	(person)	120,253	146,683	166,742
		pop. Density	(person/ha)	13	16	18
Soc Son	29,521	Population	(person)	233,166	277,571	301,489
		pop. Density	(person/ha)	8	9	10
*Other	2,769					
Total	65,757	Population	(person)	762,175	908,446	1,007,922
		pop. Density	(person/ha)	12	14	15

* Suburban area unable to be classified into subdistrict

Table 4.2.13 Future Prospects for Environmental Zone 7: Ho Tay Area (1/2)

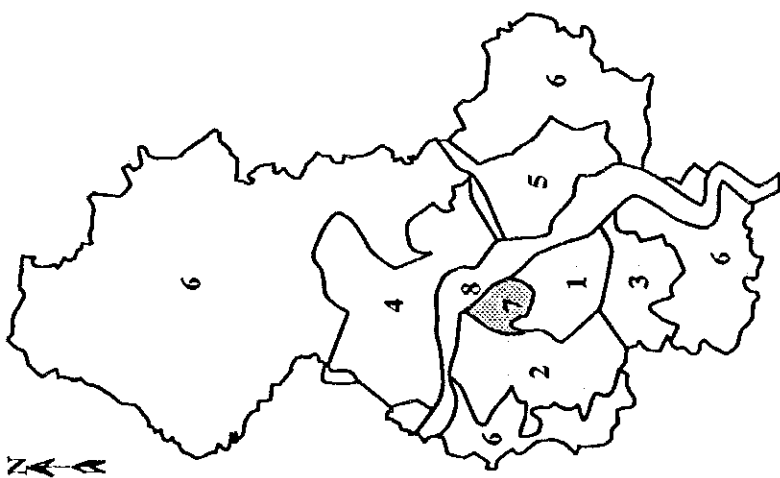
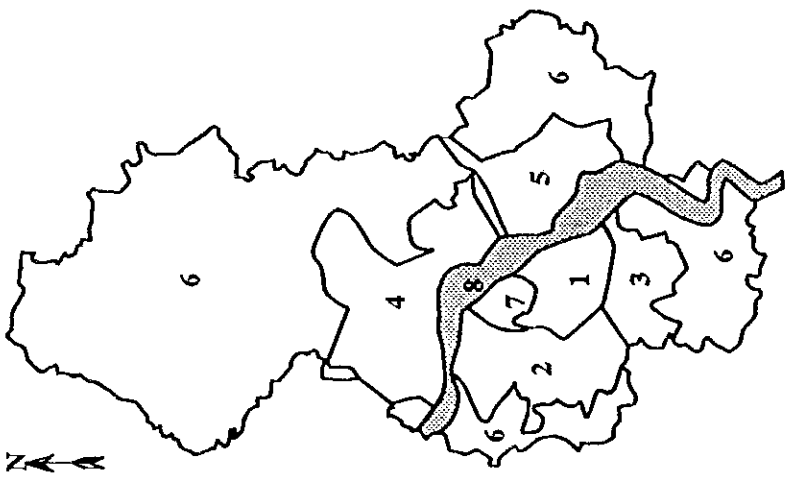
7. Ho Tay (Consists of Tay Ho District)		Location
<p>7.1 Environmental Prospects : "Waterfront Amenity Zone"</p> <p>7.2 Characteristics</p> <p>Ho Tay (West Lake) is in Tay Ho District and its broad water surface attracts many tourists and people of Hanoi. This rich water space is one of the most valuable natural and environmental resources in Hanoi. Thus, this lake should be separated from other environmental zones to be taken care of specially.</p> <p>7.3 Land Use and Urban Functions</p> <p>1) Land use</p> <p>This zone is one of the most important urban tourism resources in Hanoi because of its broad area and location close to center of the city. Planned land use doesn't show any remarkable changes in the future. Most of the land will be used for commercial (hotel) and residential purposes. And some of the land will be reserved for protection of wild birds, flowers, etc.</p> <p>This zone is unique in the large cities in Southeast Asia, and its function is not limited only in earning business yield, but also gives psychological and environmental advantages to Hanoi's people. This is the reason why the zone should be independently set up in the Environmental Master Plan.</p> <p>The zone will be an indicator of environmental situation of Hanoi, and the means of realization of an eco-dream.</p> <p>2) Urbanization forecast</p>		
<p>7.2) Urbanization forecast</p>		
1997		2010
Urbanization has grown on the southern and eastern bank of the lake. Soon or later the western bank will be developed as urban.	As urbanization progresses of urbanization, wastewater will flow into the lake if efficient counter measures are not taken.	By taking environmentally efficient measures, the lake will keep its beautiful scenery and clean water.

Table 4.2.14 Future Prospects for Environmental Zone 7: Ho Tay Area (2/2)

7.4 Related Urban Units						
Unit	Area	Districts			1997	2010 2020
013	410	Tu Liem	Population	(person)	20,514	27,773 32,000
			pop. Density	(person/ha)	50	68 78
Total	410		Population	(person)	20,514	27,773 32,000
			pop. Density	(person/ha)	50	68 78

Table 4.2.15 Future Prospects for Environmental Zone 8: Red River Quasi Zone

8. Red River Quasi Zone (The river runs through Tu Liem, Tay Ho, Ba Dinh, Hoan Kiem, Hai Ba Trung, Thanh Tri Districts in its right bank, and Dong Anh, Gia Lam Districts in its left)	Location
<p>8.1 Environmental Prospects : " Motherly Romantic River Front for Hanoi "</p> <p>8.2 Characteristics</p> <p>Red River is an inter-regional river and at the same time an international river. Therefore, the responsibility of environmental management to the river is not directly taken by Hanoi Authority.</p> <p>The river is second largest in Vietnam having many functions both positive and negative for the people. Regarding its present environmentally negative conditions, foul, muddy, and flood, more effective improvement is/will be needed.</p> <p>8.3 Land Use and Urban Functions</p> <p>1) Land use</p> <p>Basically any kind of development beside the bank of the river is forbidden except river improvement, necessary infrastructure for flood control, river port, and/or water resource. Therefore, the land use is completely limited in the Urban Master Plan 2020, which plans 3 ports and 1 river park only.</p> <p>The river's urban function would be to provide recreational space (fishing, boat, water sports, etc.), water way for traffic, and wide space to avoid uncomfortable scenic blockade in the congested city. Furthermore, as a receiver of well-treated wastewater if important in the aspect of infrastructure.</p> <p>Due to management of the river by the central government, the Environmental Master Plan of Hanoi couldn't mention any initiatives, but it hopes to.</p> <p>2) Urbanization forecast</p>	
<p>1997</p> <p>Important river lane to convey materials, animals, vegetables, and passengers.</p>	<p>2010</p> <p>ditto</p>
	<p>2020</p> <p>Could be a clean and romantic river besides being industrially important one.</p>