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Reducing regulatory burden for a sustainable development: Combining TPLMS & TISVCS in the capital region, Korea

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Abstract
The purpose of this paper is finding ways to integrate Total Pollution Load Management System (TPLMS) and Total Industrial Site Volume Control System (TISVCS) in capital region, Korea to reduce regulatory burden on businesses, and thereby helping to achieve sustainable development. The TPLMS is a policy adopted to improve air quality in capital region while the TISVCS was adopted to control population concentration in capital region, Korea. Both policies have different objectives, but they have a common ground because both policies regulate location and size of business. Under the TISVCS, the government sets the maximum limit on the total industrial site volume to control population concentration in capital region. On the other hand, TPLMS is the environmental policy newly adopted in 2007 to control the total amount of pollutant emission in capital region. The TISVCS has been criticized for many years for its weak regulatory rationale and for excessive regulatory burden on businesses. One alternative solution to this problem is replacing the TISVCS with the TPLMS to control both the total amount of pollution emission and the total industrial site volume at the same time. Using system dynamics model, this paper explored its possibility and conditions under which the integrated policy could operate successfully. The paper also examined probable difficulties and preparations needed when combining the two policies.

KEYWORD: Sustainable development Korea. Reducing regulatory burden, Total Pollution Load Management System (TPLMS), Total Industrial Site Volume Control System (TISVCS)

1. Introduction

This paper aims to find out ways to combine two seemingly different policies, the Total Pollution Load Management System(TPLMS) and Total Industrial Site Volume Control System(TISVCS) in capital region, Korea. By integrating the two, regulatory burden on business could be lessened substantially.

The TPLMS is policy adopted to improve air quality in capital region while the TISVCS was adopted to control population concentration in capital region. Both policies have different objectives, but they have common ground because both policies regulate location and size of business. Under the TISVCS, the government sets the limit on the total industrial site volume every three years to control population concentration in the capital region. The TISVCS is based on the Seoul Metropolitan Area Readjustment Planning Act. Following the law, the TISVCS mandates new constructions and expansion of factories, and land use changes are allowed only within the limit of the total industrial site volume allocated by the Ministry of Construction and Transportation (MOCT) every three years. Allowances of industrial site volume to each cities and counties are based on historical records and new plan for industrial expansion. However, the TISVCS has been criticized that it disturbs business activities and lower business competitiveness. Besides, critics say that the TISVCS has been ineffective in relocating business to out of capital region and controlling population concentration.

On the other hand, the TPLMS is an environmental policy adopted in 2007 to control the total amount of air pollution in capital region instead of regulating concentration level of pollutants in the ambient air. If the TPLMS can be managed to satisfy the industrial volume cap under the TISVCS, we may not need the TISVCS. Could the TPLMS managed to achieve both environmental quality target and population control target in the capital region? This paper explores this possibility and potential difficulties when combining the two. Analysis was focused on the Gyeonggi provincial area.

2. Total Industrial Site Volume Control System in the Capital Region

Following <Table1> shows the total industrial site volume planned and implemented since 1994. The total industrial site volume is decided by several criteria such as 3 years average of land allowed for industry construction, demand from businesses, planned and implemented volume in previous year, and total administrative area. As shown in the <Table1> however, there has been a gap between the planned and implemented volume, meaning that the decision on total industrial site volume allowance does not reflect the real demand well enough. Critics argue that the validity of allocation criteria is weak, weights for criteria are not objective, and fails to consider regional balance within the capital region. Besides, special laws have been enacted to allocate additional industrial site, weakening consistency and stability of the TISVCS. With these critics, arguments have been made that the TISVCS has to be abolished.

<Table1> Total Industrial Site Volume planned and implemented in Capital Region (unit: 1000 m^2)

	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06
TISV planned(A)	1,827	4,260	4,204	4,226	3,990	2,746	4,705	2,942	2,766	2,766	3,426	3,006	5,095
Implemented(B)	1,315	3,384	3,674	2,757	1,000	2,662	4,648	2,681	2,757	2,718	3,337	2,300	3,871
B/A(%)	72.0	79.4	87.4	65.2	25.1	96.9	98.8	91.1	99.7	98.3	97.4	76.5	76.0
Remains (GyeongGi Do)	-	-	-	-	-	578	1,984	700	630	1,139	85	-	-

3. Total Pollutants Load Management System in the Capital Region

The Total Pollutants Load Management System is a newly adopted air pollution management policy to improve ambient air quality in the capital region. It estimates maximum allowable air pollutant emission within a limit of environmental carrying capacity and allocate the total pollutants load to cities and counties in the capital region. The Total Pollutants Load Management System deals both air and water pollution. However, considering the purpose of this paper, focus was on the Total Air Pollutants Load Management System in Gyeonggi Province.

The land area of capital region (including Seoul and Incheon) is only 12 % of the total national land area. But it accounts for 46% of the total population and vehicles. The air pollution level in the capital region marks 1.7-3.5 times higher than those in other major cities globally, and social costs inflicted by air pollution reach 10 trillion Won (8.7 billion USD) annually. Responding to these serious challenges, the Ministry of Environment has been promoting the Special Measures for Metropolitan Air Quality Improvement. The special measures include total air pollution load management, emission trading system, and mandatory purchase of low emission

vehicles. Such efforts led to the legislation of the Special Act on Metropolitan Air Quality Improvement in December 2003. According to the plan, 6 trillion Won (5.2 billion USD) is planned to be invested by 2012 to promote the Special Act in stages, which will lead to a substantial reduction of major pollutants including particulate matters and sulfur oxides(MOE, 2008).

For the total air pollution load management, the MOE designated 24 major cities in the Gyeonggi Do , Seoul, and Incheon metropolitan cities as the Air Quality Control Zones, and introduced detailed measures for air quality improvement in the respective region and its vicinities.
The total air pollution load management policy started from July 2007. Industrial sites discharging over 30 ton of NOx, 20 ton of SOx, and 1.5 ton of dusts are subject to the Total Pollution Load Management System.[1] The Emission Trading System is planned to be adopted to allow a market for emission trading among industries.

<Table2> Air Quality Control Zone

Cities & Province	**Control zone**
Seoul	Whole area
Incheon	Whole area except Ongjin county(Ongjin County Yeongheung Myeon)
Gyeonggi Do	Gimpo, Goyang, Uijeongbu, Namyangju, Guri, Hanam, Seongnam, Uiwang, Gunpo, Gwacheon, Anyang, Gwangmyeong, Siheung, Bucheon, Ansan, Suwan, Yongin, Hwaseong, Osan, Pyeongtaek, Paju, Dongducheon, Yangju, Icheon 24 cities

<Table3> Target Industry under the TPLMS

Pollutants	2007.7.1-2009.6.30	2009.7.1 after
Nox/year	Over 30 ton	Over 4 ton
SOx/year	Over 20 ton	Over 4 ton
PM10/year	Over 1.5 ton	Over 0.2 ton
Industry size	Class 1 industrial site	Class 1-3 industrial sites

Class 1 industry: industry with more than 80 tons of total emission a year.
Class 2: 20-80 tons a year. Class 3: 10-20 ton a year. Class 4: 2-10 ton a year.
Class 5: less than 2 tons of emission a year.

[1] According to the original plan, an industrial site exceeds the emission cap will be imposed charges per 1kg emission volume. (4,260 won per 1kg of NOx, 7,976 won per 1kg of SOx, and 13,193 won per 1kg of dusts)

<Fig1> Total Air Pollutants Load Management Zone

Source: Ministry of Environment. 2005. *Master plan for Air Quality Management in the Capital Region*

<Table4> Emission cap of Total Air Pollutants Load Management Zone to achieve target standard

	SOx	NOx	PM_{10}	VOC
2001 emission(ton)	70,188	309,387	14,681	262,479
Reduction ratio (%)	38.7	53.0	38.7	38.7
Emission cap to achieve target standard (ton)	43,025	145,412	8,999	160,900

Ministry of Environment. 2005. *Master plan for Air Quality Management in the Capital Region*

<Table5> Regional allowance of pollutants under the TPLMS

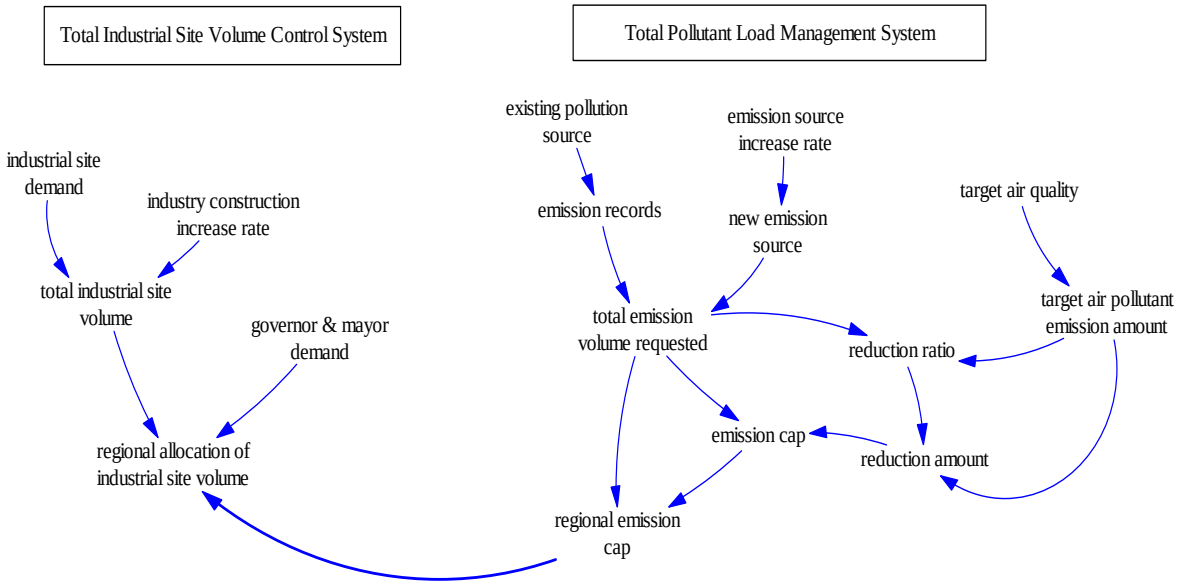
	Gyeonggi Do		Seoul		Incheon		total		Reduction ratio(%) compared to 2001
	2001 emission (ton/yr)	2014 Emission cap(ton/yr)	2001 emission (ton/yr)	2014 Emission cap(ton/yr)	2001 Emission (ton/yr)	2014 Emission cap(ton/yr)	2001 Emission (ton/yr)	2014 Emsion cap(ton/yr)	
NOx	151,015	70,977	98,188	46,148	60,184	28,286	309,387	145,412	53.0
SOx	43,427	26,621	10,399	6,375	16,362	10.030	70,188	43,025	38.7
PM10	7,706	4,724	4,408	2,702	2,567	1,574	14,681	8,999	38.7
VOC	119,912	73,506	88,538	54,274	54,029	33,120	262,479	160,900	38.7

Ministry of Environment. 2005. *Master plan for Air Quality Management in the Capital Region*

Gyeonggi Do. 2006. *Implementation Plan for Air Quality Management Master Plan in the Capital Region*

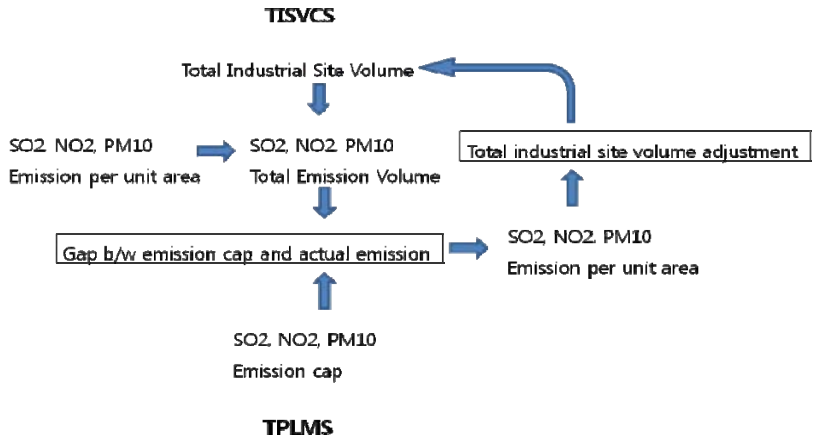
4. Linkage between the TISVC and the TPLMS

<Fig2> shows simplified decision process for industrial site volume allocation and emission cap on each region. The thick line from 'regional emission cap' to 'regional allocation of industrial site volume' indicate that both the TISVCS and the TPLMS is a closely related one. If the total amount of air pollutants from industrial sites in Gyeonggi Do is within the emission cap under the TPLMS, or if the industrial site volume is allocated so that it satisfies emission allowance in each region, the two systems can be combined into one policy.



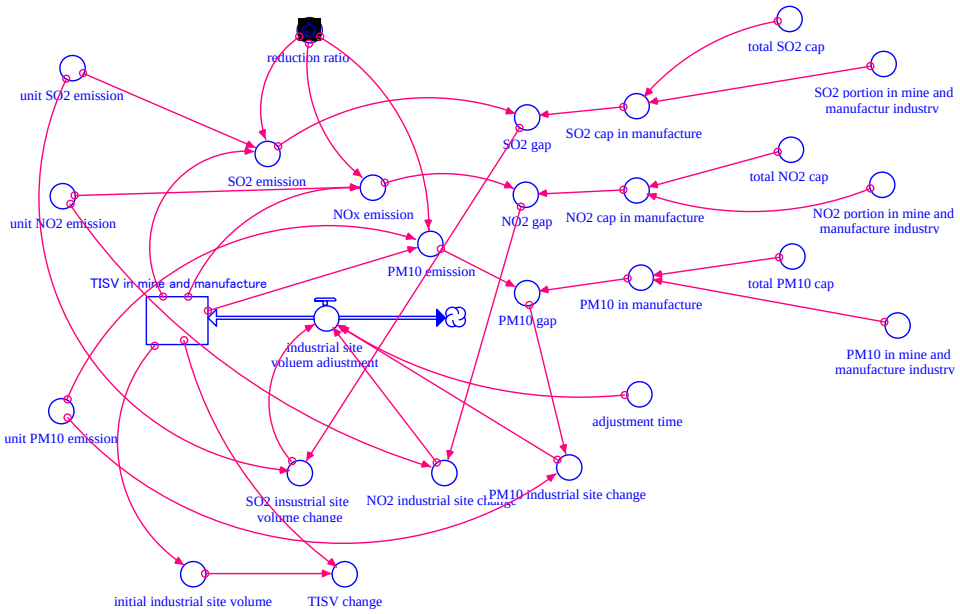
<Fig2> Linkage between the TISVCS and the TPLMS

If the two polices are combined together, the TISVCS can overcome the critics it has been received and businesses are better off from the simplified regulation. What would be the condition under which it could be operated successfully? What could be problems and difficulties to implement it? What preparations are needed to implement it? System dynamics model was build to explore these questions. Following <Fig3> shows simplified structure of system dynamics model.



<Fig3> Conceptual Model to Link TISVCS and TPLMS

<Fig3> shows that the TISVCS and the TPLMS can be linked through the conversion factor, 'SO2, NO2, PM10 Emission per unit area'. Total amount of air pollutants from the industrial sites can be estimated by the amount of air pollutant per unit area multiplied by the total area of industrial sites. Then, the total air pollutants produced by the industrial sites is compared to the emission cap under the TPLMS. The gap between the emission cap and actual amount of air pollutants produced can be translated into industrial site volume using conversion factor, air pollutants per unit area. If total emission volume is less than the emission cap, more industrial site can be allocated. Industrial site volume is to be decreased when it turns out the other way around. The extent to which technology and clean fuel can reduce air pollutant emission per unit area could be the most important factor affecting the total industrial site volume. Following figure shows the flow diagram of the combined model.



<Fig4> TISVCS and TPLMS Combined Model Flow Diagram

5. Data used in Simulation

Since the unit used in the TPLMS and TISVCS is an amount of pollution emission a year (ton/year) and total industrial site volume allocated (m2/year) respectively, amount of pollution emission per unit area data is needed to link the two systems. Especially, data for an amount of SO2, NO2, PM10, VOC emission by industry type per unit area, amount of pollutant emission per unit value added, output value per unit area by industry types are important data to be prepared for simulation. Unfortunately, however, data for emission amount per unit area by industry types was unavailable and proxy data was used for simulation. Total emission amount for each air pollutants –SO2, NO2, PM10, VOC- and total industrial site volume in Gyeonggi Do was used to estimate emission amount for each pollutant per unit area in mine and manufacturing sector. <Table6> shows the data used for the simulation. <Table6> shows the data used for the simulation.

<Table6> Data used for simulation

	Nox	Sox	PM10	VOC
1. Total emission amount (ton/2004)	210078	31387	9346	161266
2. Share of emission in production process & fuel burning (1)	0.119	0.315	0.282	0.15
3. Emission in manufacturing sector (1*2)	24999.28	9886.905	2635.572	24189.9
Total industrial site –mine and manufacturing sector- area in m^2 (2)	99399120			
Number of industry 2005 (3)	37903			
Emission per unit area (kg/m^2)	0.251504	0.099467	0.026515	0.243361
Emission per industry (kg/industry)	659.5595	260.8476	69.53465	638.2054
Average area per industry (m^2/industry)	2622.46			

(1) Source:Annual report on air pollution emission 99-04,

(2) source: Mining & Manufacturing Statistics Survey 2004.

(3) Industry with more than 5 employees

Simulation was conducted based on five scenarios; BAU as no reduction in emission amount, and 10%, 20%, 30%, 40% reduction of emission amount.

Emission reduction scenarios reflect necessary reduction ratio to meet the emission cap targeted by the TPLMS. For example, estimated emission amount of NOx, SOx, PM0 in the year 2014 needs to be reduced 59%, 30.2%, 48.9% respectively. So, in order to achieve the policy target of TPLMS, minimum 30% and maximum 59% of emission reduction is necessary. To be a conservative simulation, it assumed minimum 10% and maximum 40% of emission reduction.

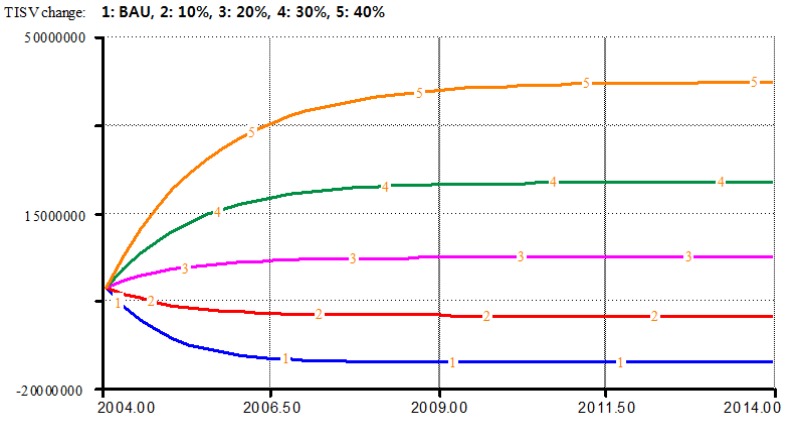
<Table7> Emission reduction target, Gyeonggi Do (ton/year)

	NO_x	SO_x	PM10	VOC
Estimated emission amount in 2014 (1)	173,337	38,147	9,243	193,751
Emission cap in 2014	70,977	26,621	4,724	73,506
Emission reduction target in 2014 (2)	102,360	11,526	4,519	120,245
Reduction ratio (2/1)	59.0%	30.2%	48.9%	62.0%

Gyeonggi Do. 2006. *Implementation plan for Capital Region Air Quality Management Master Plan*.

6. Simulation Result

Simulation result for Gyeonggi Do with simulation period from 2004 to 2014 is shown in the <Fig5> and <Table8>.



<Fig5> Total industrial site volume change with different assumption

<Table8> Changes in Total Industrial Site Volume with different emission reduction scenarios (m^2)

Year	BAU	10%	20%	30%	40%
2004	99,399,120	99,399,120	99,399,120	99,399,120	99,399,120
2005	89,081,215	95,738,557	102,931,337	110,690,886	119,049,464
2006	85,816,565	94,418,007	104,378,134	115,921,801	129,307,066
2007	84,783,609	93,941,618	104,970,741	118,345,024	134,661,599
2008	84,456,776	93,769,761	105,213,473	119,467,583	137,456,698
2009	84,353,363	93,707,763	105,312,896	119,987,609	138,915,758
2010	84,320,643	93,685,398	105,353,620	120,228,512	139,677,396
2011	84,310,290	93,677,329	105,370,301	120,340,110	140,074,976
2012	84,307,014	93,674,418	105,377,133	120,391,807	140,282,515
2013	84,305,978	93,673,368	105,379,931	120,415,757	140,390,852
2014	84,305,650	93,672,990	105,381,078	120,426,851	140,447,404
Total	**-15,093,470**	**-5,726,130**	**5,981,958**	**21,027,731**	**41,048,284**

<Table8> shows that if there is no emission reduction(BAU), 15.09km2 of total industrial site volume, an annual average of 1.5km2 need to be decreased during the simulation period to meet the emission cap. With 10% reduction scenario, 5.7km2 of total industrial site volume, annual average of 0.57km2 of industrial site volume needs to be decreased. But with the emission reduction scenario more than 20%, total industrial site volume can be increased substantially. With 20%, 30%, 40% reduction of emission amount, total industrial site volume can be increased 5.98km2, 21.0km2 and 41.0km2 respectively during the 10 years period.

Comparing this simulation result with actual increase in total industrial site volume from 2004 to 2006 in the <Table1>, it seems reasonable to say that if the emission reduction ratio is higher than 30%, combining the TISVCS and TPLMS can be successful. According to the <Table1>, total industrial site volume increased during 2004 to 2006 was 9.5km2, an annual average increase of 3.2km2. Since the simulation result with 30% reduction scenario was 2.1km2 of annual increase in industrial site volume, more than 30% of reduction ratio is necessary to satisfy the TISVCS. With 40% reduction scenario, annual average increase of industrial site can be as much as 4.1km2 which is more than average increase of total industrial site volume implemented,

3.2km2. With this simulation result, it may be fair to say that if 40% of emission reduction can be achieved, the TISVCS and TPLMS can satisfy each other and can be combined into one policy.
40% of emission reduction scenario is not an overly optimistic one because target emission reduction ratio set by the Gyeonggi Do ranges from the minimum 30.2%(SOx) to the maximum 62%(VOC) which is higher than the reduction ratio assumption used in the simulation.[2]

7. Conclusion

From the simulation result, it seems clear that the TISVCS and TPLMS can be combined into one policy successfully when the pollution emission reduction ratio reaches around 40%. Considering all the critics made against the TISVCS so far, replacing the TISVCS with TIPLMS is a highly plausible alternative for regulatory simplification.
However, combining the two policy needs careful preparations. First of all, more detailed implementation plan need to be established. For this, information on emission amount and industrial site volume by industry type and size(class 1 to 5), emission amount per unit output and per value added are needed. Because of unavailability of data on emission amount by industry type and size, simulation in this study relied on the aggregate data of Gyeonggi Do and used proxies for the unavailable data. So, these data needs to be collected and more detailed analysis with reliable data is necessary.
Second, the TPLMS applies only to class 1, 2, 3 industries and to those who produce NOx, SOx, PM10 more than 30 tons, 20 tons, 1.5 tons respectively until the 2009.7.1 and 4 tons, 4 tons and 0.2 tons respectively after 2009.7.1. So, the TPLMS does not apply to class 4 and 5 industries. Thus, how to manage these industries can be a problem. For short term, measures for small industries not subject to the TPLMS application need to be made because the class 4 and 5 industries consist 29.5% and 61.4% of total number of industries in Gyeonggi Do.
Third, how to managing class 1-3 industries that are exempted from the TPLMS because they produce NOx, Sox, PM10 below the TPLMS standards can be another problem. For these industries, industrial site volume regulation needs to be deregluated. Instead, by expanding type of pollutant to be controlled under the TPLMS, those industries can be regulated too. For example, as reduction of CO2 emission is inevitable due to the international treaties on global warming, adding CO2 reduction requirement in the TPLMS is one possible way.
According to the simulation results, when Gyeonggi provincial government achieves emission reduction ratio as announced, the total industrial site volume can be increased more than that of current increase. Besides, by adding other pollutants such as CO2 in the TPLMS, it can provide a good opportunity to prepare for the emission trading market.

References

Gyeonggi Do. 2006. *Implementation Plan for Air Quality Management Master Plan in the Capital Region*

Gyeonggi Research Institute. 2004. *A Study on Effect of Capital Region Regulation*

Korea Environmental Research Institute. 2005. *Regional Environmental Management under the Total Pollution Load Management System.*

Korea National Statistical Office. 2006. *Mining and Manufacturing Statistical Survey 2004.*

Lee, D.S. 2007. “Review on the Effect of Deregulation in Capital Region”. *Public Land Law Review.* Vol.35.

[2] 59.0% for NOx, 48.9% for PM10. See <Table 7>

Lee. S.G. 2006. “Problem and Improvement Method of Land Use in the Capital Region”. *Public Land Law Review.* Vol.34.

Ministry of Environment. 2004. *A Guidebook for Total Water Pollution Load Management*

Ministry of Environment. 2005. *Master plan for Air Quality Management in the Capital Region*

Ministry of Environment. 2007.1. *Total Water Pollution Load Management System and its Current Status*

Ministry of Environment. 2007.7. *A Guidebook for Total Air Pollution Load Management in Industrial Site*

Ministry of Environment. 2008. 4.24. “Overview of air quality management policy”. http://eng.me.go.kr/docs/common/common_view.html?idx=7&av_pg=1&mcode=10&classno=10

National Institute of Environmental Research. 2005. *Annual Statistics on Air Pollution Emission 99-04*

National Institute of Environmental Research. 2005. *Total Water Pollution Load Management System*