

Kitakyushu Initiative for a Clean Environment: Successful and Transferable Practices

Dalian (China): Removal and Modification of Polluted Enterprises

Institute for Global Environmental Strategies¹

Target area: Industrial pollution management

Time Period: 1995 to 2000

<u>Contents</u>	<u>Page</u>
1. Background and environmental challenges	2
1.1 Atmospheric pollutant emissions and major sources	2
1.2 Emission of wastewater and major sources	2
2. Why removal and modification of polluting enterprises?	3
3. Achievements for industrial pollution control	3
3.1 Environmental quality	3
3.2 Potential economic and social benefits	5
3.3 Urban environmental performance	5
4. Implementation of removal and modification of polluting industries	6
4.1 Actions	6
4.1.1 Conditions of removal and modification of polluting industries	6
4.2 Implementation	7
4.2.1 Policies and regulations	7
4.2.2 Administration	7
4.2.3 Relevant implementation scheme	7
4.2.4 Financial issues	8
4.2.5 Technology	8
4.2.6 Monitoring	8
4.2.7 International cooperation	8
4.3 Example of concrete project: Dalian Pharmaceutical Company	9
5. Transferable Practices	10
5.1 Win-win approach through removal and modification of key polluting enterprises	10
5.2 Preferred conditions	10
5.3 Notes for implementation	11

<u>Tables and Figures</u>	<u>Page</u>
Fig. 1 Emission Trend of COD & SO ₂ in Dalian from 1986-2001	3
Fig. 2 Air quality in Dalian	4
Table 1 Location of industries and enterprise in central area of Dalian, 1993	2
Table 2 Atmospheric pollutant emissions and major sources	2
Table 3 Main development and environmental indicators	5
Table 4 List of major pollutant sources	6
Table 5 Removal and modification of Dalian Pharmaceutical Company	9
Table 6 Win-win approach	10
Table 7 Preferred conditions	10

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1. Background and Environmental Challenges

Dalian is located in the southern part of Liaodong peninsula in China, along the coast. The current population is 5.404 million (urban population: 2.597 million; rural population: 2.807 million). Dalian's GDP has increased from 27 billion yuan in 1992 to 111 billion yuan in 2000, with 14.2% average rate of increase per annum. Material object assets have increased from 75.8 billion yuan to 260.9 billion yuan, with an annual average rate of 16.7%.

Dalian is an important industrial city in Northern China; the development and change of Dalian's urban environment is closely related to industrial development. The proportion of tertiary industry in the GDP has risen from 32% to 44% following industrial structure transfer. A large number of heavy industry enterprises are concentrated in Dalian, i.e. chemical, metallurgical, petroleum and building materials (Table 1). These industries are mainly located in the centralized urban area where there is mixed land use for both residential and commercial areas. The emissions of air and water pollutants, such as smoke and dust from coal, from these industrial sources are the main causes of urban pollution in Dalian.

Table 1 Location of Industrial Enterprises in the central area of Dalian, 1993

District	No. of Enterprises	Gross Industrial Output Value (Billion Yuan)
Ganjingzi District	82	13.180
Shahezi District	81	5.586
Xigang District	40	3.097
Zhongshan District	35	2.148
Jingang District	66	1.364
Lushunkou District	29	0.585

Source: Dalian's Yearbook

1.1 Atmospheric Pollutant Emissions and Major Sources

In Dalian, the major air pollutants are SO₂, and dust and smoke from industries, which are mainly produced by power, gas, metallurgical, and cement manufacturing industries (Table 2).

Table 2 Atmospheric pollutant emissions in 1997

Pollutant emission	Stationary source (%)	Non-point source	Total
SO ₂	76,969 (92.4%)	6,239	83,298
NO _x	57,306 (93.2%)	4,181	61,487
TSP	47,086 (70.8%)	19,428	66,514
CO ₂	12,400,453 (94.8%)	686,294	13,086,747

1.2 Emission of Wastewater and Major Sources

The leading pollutants in urban wastewater are COD, suspended particles, heavy metals, and oil. The leading pollution sectors are petrochemical and chemical industries, which comprised 87% of the total amount of industrial wastewater discharge in 1998. The Dalian government decided that the removal and modification of key pollution enterprises was a major concern, as the distribution of industries was the cause of serious environmental problems.

2. Why Removal and Modification of Polluted Enterprises?

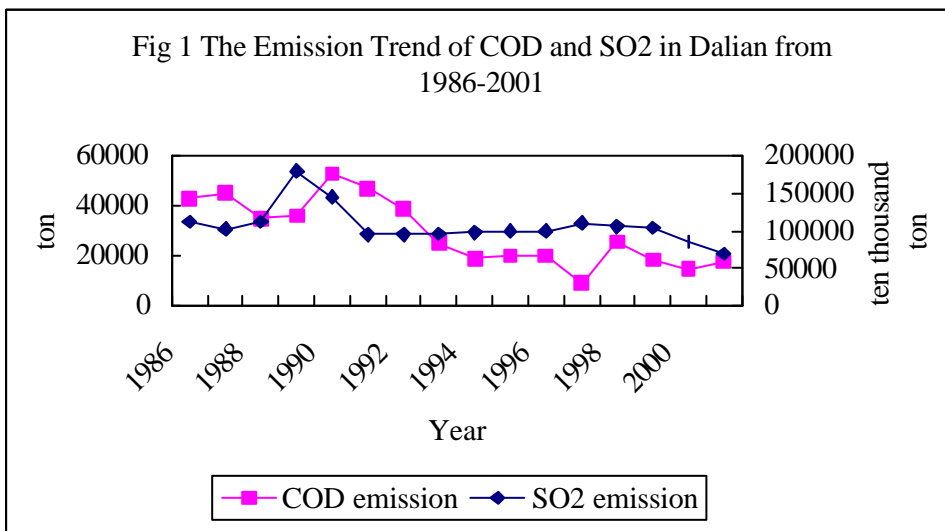
Serious air and water pollution issues are a result of pollution from large-scale heavy industries that are located in the central area of city. This is a major reason for the removal and modification of these polluted enterprises. Relocation is an effective method as stationary source measure for obsolete manufacturing facilities. Dalian decided to move polluting enterprises from the central area of city and divide the city into areas, emphasizing treatment of heavily polluted areas. Additionally, the city aimed to increase technological and productive levels of the removed companies, as well as management capacity for industrial pollution control.

3. Achievements for industrial pollution control

In 1995, Dalian formulated a guiding principle for urban development to revise the industrial structure in overall city planning to improve the environment. Eighteen plans for removal were issued until 2000. To date, 105 enterprises have been removed creating a space of 3 million m² in the urban area. By adjusting the industrial structure, removing and modifying key polluting enterprises, phasing out backward products and adopting clean process, the total pollutant amount has decreased greatly. In total, 158 enterprises have been targeted for removal and modification.

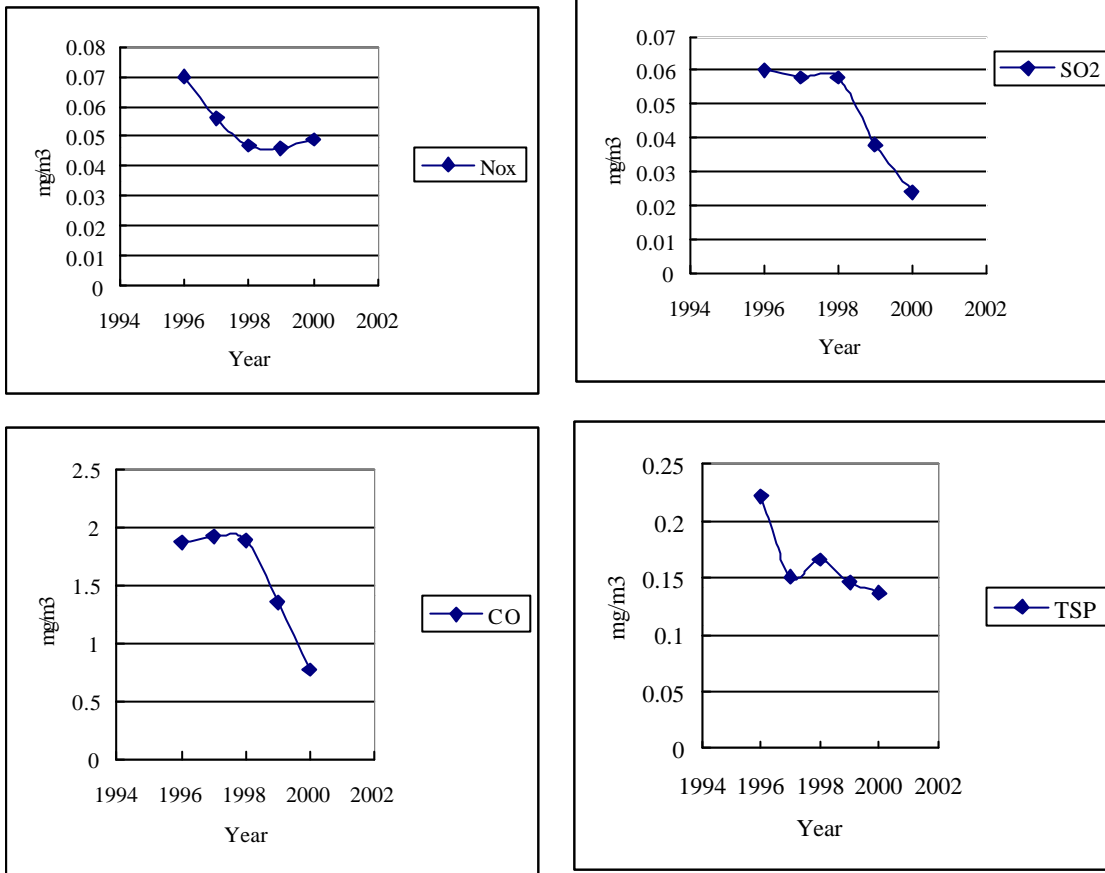
3.1 Environment quality

Through this program, environment quality has been effectively improved.



The comprehensive air pollution index had dropped from 7.19 (1995) in 1990 to 4.44 in 2000. The position of the comprehensive air pollution index of Dalian has risen from No. 27 in 1995 to No.12 in 2000 in a comparison of 47 key cities in China.

Fig 2. Air quality in Dalian



Note: Removal and Modification of Polluted Enterprises began in 1996. Implementation period was from 1996 to 2000.

3.2 Potential economic and social benefits

Table 3 shows the main development and environmental indicators of Dalian and annual statistics of the decrease in pollutants after control and modification.

Table 3 Main development and environmental indicators

ECONOMIC INDICATORS	
Percentage increase of GDP	Annual average of 14.2% (1996-2000)
Increase in land price of constructed area	100 times (40 Yuan/ m ² (1992) to 4000 Yuan/ m ² (1999))
Industrial transfer	11:47:42 (1996) to 9.5:46.5:44 (2000)
Increase in urban construction development (1997-1999)	90 enterprises had been removed out with the result of the vacated land of 2.4 million m ² : 0.42 million m ² for business and office, 1.13 million m ² for residential area, 0.85 million m ² for urban road, square and dwelling green. 50% of citizens moved into new settlement
Foreign investment	Up to 9.28 billion Yuan
ENVIRONMENTAL INDICATORS	
<i>Air (Decrease in air pollution emission density (1996-2000))</i>	
Decrease amount/rate of gas	4.7 billion m ³ ; 96%
Decreased amount/rate of dust	5292 tons; 95%
Decreased amount/rate of smoke	2249 tons; 88.6%
TSP	0.222 to 0.137 (Standard is 0.2m g/m ³)
SO ₂	0.060 to 0.024 (Standard is 0.06m g/m ³)
NO ₂	0.070 to 0.029 (Standard is 0.08 m g/m ³)
Natural dustfall	20.0 to 17.2 (ton/km ² per month)
<i>Water quality</i>	
Decreased amount/rate of industrial waste water	20.059 million tons; 52%
Decreased amount/rate of COD	40 thousand tons; 93.6%
Decreased amount/rate of petroleum	3137 tons; 99%
Oils	0.048 mg/L (1995) to 0.027mg/L(2000)
Inorganic nitrogen	0.198 mg/L(1995) to 0.105mg/L(2000)
<i>Solid waste</i>	
Decreased amount/rate of solid waste	1.45 million tons; 94.2%
<i>Natural Conservation</i>	
Green areas coverage	5.5%(1992) to 40.5%(2000)
Green area per capita	3m ² (1992) to 8.5m ² (2000)

3.3 Urban environmental performance

The removal and modification of key polluting enterprises was a focal point for the government in implementing its “sustainable development strategy” from the mid-1990s. Implementation was carried out over four years. This experience was listed as a major achievement in Dalian’s application for the Global 500 Award in 2001, which they ultimately received. Dalian has also been recognized as a model city of national environment protection and a national garden city. Dalian is also recognized as one of Sino-Japan environmental cooperation “demonstration cities.”

4. Implementation of Removal and Modification of Polluted Enterprises

4.1 Actions

4.1.1 Conditions of removal and modification of polluted enterprises

- Specialized industries (casting, forging, electroplating, cement) have merged and have been restructured.
- With non-competitive products, obsolete equipment, low profits, and no funding to rectify these problems, production and management of the enterprises is difficult.
- The heights of chimneys are low, and pollutant concentration on the ground is high.
- Production has a serious impact on the environment and jeopardizes the health of residents and the ecosystem.
- With enterprises locating in good areas, land may not be used to full potential and resources may decrease.

Table 4 List of Major Pollution Sources

Company	Chimney Height	Total Emissions			Concentration on Ground			Remov. / Modific.
		SO ₂ (t)	NO _x (t)	TSP (t)	SO ₂ (mg/1000m ³)	NO _x (mg/1000Nm ³)	TSP (mg/1000Nm ³)	
Huaneng Power Plant	240	24,023	17,737	834	1	1	0	
Dalian Chemical Plant	30-80	12,123	9,150	1,998	25	20	4	
Dalian Thermo Electricity	130	9,031	6,001	1,411	2	1	0	
Chunhai Power Plant	135	3,864	1,103	575	1	0	0	
Dalian Steel Mill	35-50	1,928	1,712	4,495	22	22	47	Yes
Dalian Potassium Chlorate Co.	80	1,395	864	200	1	1	0	
Dalian Power Plant Main Factory	50-60	1,337	205	0	7	1	0	
Dalian Dye Co.	30	1,209	373	152	4	0	0	Yes
Dalian Coach Mfg.	25-60	980	559	500	13	4	2	
Dalian Locomotive Mfg.	45	855	568	134	6	3	1	
Dalian 7 th Petroleum	80	846	787	0	1	1	0	
Dalian Glass Mfg.	30	825	673	144	9	6	1	Yes
Dalian Cement Mfg. Co.	35-50	554	1,544	9,218	7	712	838	
Qiange Cement Mfg., Co.	36	480	106	100	9	2	1	
Dalian Brewery	50	443	295	277	9	5	4	
Dalian Special Steel Mfg. Main Factory	25-40	392	326	327	4	0	1	
Dalian White Ashe Mfg.	25	274	64	150	12	2	0	
Dalian Pharmaceutical Co.	40-45	138	52	500	7	2	12	Yes
Dalian 3 rd Cement Mfg.	34	128	532	125	0	1	0	
Dalian 1 st Gas Mfg.	45	123	323	192	10	21	12	Yes
Dalian 2 nd Gas Mfg.	63	83	535	837	5	24	42	Yes

4.2 Implementation

4.2.1 Policies and Regulations

The Dalian government has issued several documents regarding the removal and modification of industries. One such document issued in 1995 is, “Relevant regulations for the removal and modification of development for urban enterprises in Dalian”. Contents of that document are as follows:

- (i) Simplifying approval procedures, increasing speed of removal/modification of enterprises;
- (ii) The planning department works to ensure benefits for the removed enterprise with regard to acquiring new land, in conformity with overall city planning;
- (iii) The removed enterprise may enjoy a series of preferential exemptions for local revenues for a certain period with certain conditions.

4.2.2 Administration

In 1995, the Dalian government strengthened the industrial structure adjustment and set up a committee headed by former mayor Mr. Bo Xilai. This committee was comprised of representative of relevant committees, agencies and offices. The Environmental Protection Bureau of Dalian is the main implementation body with cooperation of other relevant departments. Functional departments for environmental protection have grown from under 100 staff to nearly 1000 in 2000, effectively reinforcing implementation of environmental protection activities.

4.2.3 Relevant implementation scheme

Dalian has taken the following 5 measures with regard to adjustment for old industries that are located in residential and commercial areas:

- Relocation: Profitable enterprises are able to establish new factories outside the urban area and attract foreign investment
- Removal: Unprofitable enterprises are closed according to legal procedures
- Merger: Similar small-scale enterprises are relocated to one area to collectively carry out production so that new industries can be introduced
- Reduction of large-scale industries: In cases where large-scale industries occupy large areas of land, the industry may be relocated, removed or terminated so that new industries can be introduced
- Retail: Enterprises that can attract foreign and domestic investment may be sold in order for the purchaser to introduce technical modifications or develop tertiary industries in the area.

Through the above adjustments, asset increments, industry transfer, function change and staff redistribution could be achieved.

4.2.4 Financial issues

- Provide incentive by economic instruments
Preferential policy for removed enterprises: When original land is sold, 40% -70% of all removal fees and the comprehensive land price(average price difference between locations) will be provided to the removed enterprises. The planning department works to ensure benefits for enterprises to acquire the new land required by the removed enterprises. The removed enterprise may enjoy a series of preferential exemptions for local revenues for a certain period with certain conditions, which greatly mobilizes the initiatives of the removed enterprises.
- Encourage foreign direct investment and set up joint venture companies to implement the removal and modification of polluted enterprises
- Analyze financial capacity of enterprises for removal and modification (project contents, production capacity/per year, total investment, financial evaluation, economic evaluation)

4.2.5 Technology

- Identify pollution sources through scientific research
- Develop the technology of less polluting industries, cleaner production, flue gas desulphurization, energy transfer

After moving to the new plant, Dalian Dyeing Industry and Dalian First Organic Chemistry Company improved their skills and developed a combination of productive factors, with which they began making new products, additionally, the industry continued production on only 20 products (out of 30 former products). This change decreased the pollution rate by 90%.

After relocation, Dalian Chemical Oil & Fat Industry successfully eliminated inferior materials of oxidized fatty acid paraffin and fatty alcohol, and produced high level facial soap, washing soap, cleanser and other chemical products

After moving to a new factory, Dalian First Gas Industry completed a new productive line by adopting new air controlled gasoline technology instead of coal. As a result, pollution levels are low.

4.2.6 Monitoring

- At present, there are on-line monitoring systems, as follows: 6 smoke & dust control points; 70 pollution monitoring equipments; 10 automatic air pollution monitoring station.

4.2.7 International cooperation

Dalian is listed as one of the Sino-Japan environment cooperation demonstration cities. The comprehensive and scientific environmental protection plan was developed through the technology cooperation scheme by the Japanese central and local governments.

4.3 Example of Concrete Project: Removal and Modification of Dalian Pharmaceutical Company

Table 5 Removal and Modification of Dalian Pharmaceutical Company

Problem	Measures	Effect
Located in the central zone of city and impacted daily life of surrounding citizens	Removal of factory and securing land	Improvement of urban environment and effective enhancement of economic activity
Factory and equipment were obsolete and manufacturing efficiency was low. Leakage of chemicals during the production process was high.	Renewal of equipment: Installation of the latest equipment in the new factory; avoidance of leakage of chemicals during the production process; Product diversification and improvement of production process	Significant reduction of waste emissions; Economic benefits through large-scale production
TSP emissions were over standards. The leakage of chemicals during the production process was significantly higher than the standard.	Air pollution countermeasures: Install denitration equipments and desulfurizing equipment on boiler with 30t; Install dust collector equipment; Use activated carbon treatment method	Atmospheric Pollutant Emissions: Burning: SO ₂ : 260t/y to 161.2t/y TSP: 500t/y to 252.6t/y Process: Acetone (CH ₃) ₂ CO: 136t/y to 23.9t/y Butylester acetate: 300t/y to 7.1t/y
Wastewater was not treated and flowed directly into drainage. pH, BOD, COD and SS were significantly over standards. Zinc sulfate was discharged during the production process, and the amount of organic and inorganic chemicals generated was significantly over standards	Water pollution countermeasures: Install industrial wastewater treatment pond	Emission of Wastewater: COD: 10074t/y to 312.8t/y SS: 1314t/y to 312.8t/y
Amount of germ from solid waste was discharged into drainage, also causing water pollution. Residents had complaints about odor and noise pollution.	Use activated carbon treatment for improving offensive odor; Use of low-noise machines and sound absorption /sealed building structure	Solid waste: Recycle Zinc from waste of medicine Zinc sulfate (ZnSO ₄): 500t/y to 16.7t/y

5. Transferable Practices

5.1 Win-Win Approach through removal and modification of key polluting enterprises

The issue of removal and modification of key pollution enterprises is an effective measure for achieving stationary source control, because end of pipe and cleaner production usually can be applied at the same time. This approach can also contribute to urban re-planning. Dalian successfully showed their win-win approach by adopting this issue (Table 6).

Table 6 Win-Win Approach

<i>Adjusting industrial layout and structure</i>	
<ul style="list-style-type: none"> ● Develop business, finance, tourist, and information industry in the central area of city ● Increase urban green areas and develop infrastructure and housing making full use of the land from the removed enterprises; improvements to the urban environment are significant ● Increase speed of controlling pollutant sources, and strict measures to control new pollutant sources ● Introduce low energy emission type businesses 	
<i>Developing modern industries</i>	
Save energy	
<ul style="list-style-type: none"> ● Reduce energy consumption of per unit production; reduce fuel consumption; reduce amount of cooling water ● Make plans, guidelines, and manuals regarding saving energy ● Check the situation of energy use in the factory 	
Cleaner production	
<ul style="list-style-type: none"> ● Make plans, guidelines, and manuals regarding saving energy ● Set up the pilot projects 	
End of Pipe	
<ul style="list-style-type: none"> ● Install denitration equipments, desulfurizing equipment, and dust collector equipment ● Install industrial sewerage treatment facilities ● Carry out hazardous waste treatment ● Expand recycling activities 	

5.2 Preferred Conditions

Implementation of this type of activity has limitations with regard to political and institutional systems, local government leadership and its capacity, land and industrial ownership, and economic development stages, among others. The following is a summary of conditions necessary for replication.

Table 7 Preferred conditions

Item	Conditions
Political	Application of a planned economy approach
Economical	<ul style="list-style-type: none"> ● Rapid economic growth period ● Rapid industrial transfer period
Geography	Cities that still have more area
Enterprise ownership	<ul style="list-style-type: none"> ● Middle and large sized state-run companies
Urban environmental management	<ul style="list-style-type: none"> ● Command & control approach ● Strict environmental regulations and standards

5.3 Notes for Implementation

- Clarification of the source of pollution is necessary in decisions related to factory relocation and clear standards applied to the type and business to be relocated.
- The implementation of cleaner production, End of Pipe (Ex. introduction of flue gas desulfurization and denitrification), and implementation of fuel conversion and incineration management must be carried out simultaneously with the relocation of businesses.
- Policies for economic growth and outside investment should operate together, with a rise in real estate prices in the urban area.
- Land supply, subsidies, and a preferential tax system for leased land should be practically applied.
- An Environmental Impact Assessment (EIA) is necessary to prevent reoccurrence of pollution after relocation.