Kitakyushu Initiative for a Clean Environment: Successful and Transferable Practices

Kitakyushu (Japan): Coexistence of Industry and Community

Institute for Global Environmental Strategies[1]

Target Area: Industrial pollution management
Time Period: 1970-2000
Research Theme: Analysis of industrial pollution management in Kitakyushu City

This study highlights the three major components of industrial pollution management:

1. Public pressure leading towards voluntary agreements for industrial pollution management
2. The capacity building of local government to enforce these agreements
3. Innovative industrial measures to reduce pollution with continued economic growth objectives.

Industrial pollution in Kitakyushu City covers air, water, noise, and waste pollution; however, we will discuss the case study of SOx pollution control management, as there is a common and joint approach for all the industrial pollution management in this City.

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Foreword: Criteria for successful practice analysis

Analysis of successful practices may be done from various perspectives. The main focus of this successful practice analysis is capacity development for urban environmental governance. This capacity can be developed with the effective and efficient adaptation of various instruments including institutional strengthening, policies and regulatory framework, public awareness and stakeholder participation, financial mechanisms, and choice of technology. On the other side environmental governance in urban areas is primarily targeted to provide efficient and effective environmental services including water supply and wastewater, solid waste management, industrial pollution management, energy-transportation-air pollution nexus management, slums and land use, and monitoring and evaluation systems.

These aspects can be defined in a detail; however, due to limitation of space, these aspects are briefly defined and major successful component for this study highlighted. For institutional strengthening, with the local governments being the primary institutions for urban environmental governance, the coverage includes management and decision-making in the local governments and their vertical and horizontal linkages. Policy and regulatory framework covers effective and efficient policies and the regulatory framework to implement or support these policies. Public awareness covers the entire range of methods and techniques to induce the awareness and its impact over stakeholder participation. Financial mechanisms cover public sector financing, private sector financing, and public-private partnerships to assess effectiveness and sustainability in this sector. Finally choice of technology covers the appropriate technology from various aspects including local or imported and labor or capital intensive. The broad picture of criteria is shown in Fig. 1.

Success practice from Kitakyushu: This is a story of very sensitive campaign by the public, which did not want to lose the industries that were their economical backbone. However, they also wanted to reduce the industrial pollution. Pressure led towards voluntary agreements between the local government and the industries to reduce the pollution. This became a success due to institutional strengthening of the city government through decentralization from the prefectural government and also due to innovative cleaner technology adapted by the industries. This improved the environment up to the required levels and also helped industries to reduce their costs of production and increase business at the end of day. In Fig. 1, the various levels of gray circles shows the level of success for such instrument in this study.

Fig. 1 Urban environmental governance

	Instruments				
Environmental Challenges	Institutional Strengthening	Policies & Regulatory Framework	Public Awareness & Stakeholder Participation	Financial Mechanism	Choice of Technology
Water Supply & Wastewater Management					
Solid Waste Management					
Industrial Pollution Management					
Energy-Transportation-Air Pollution Nexus Management					
Transportation related Pollution Management					
Slums & land-use Management					
Monitoring and Evaluation (M&E) Management					

1 Background:

Kitakyushu City was created in 1963 with the merger of the five neighboring cities of Moji, Kokura, Yahata, Wakamatsu, and Tobata. This city is located in the far northern part of Kyushu (the most westerly island of Japan's four main islands), and faces Honshu over the Kanmon Channel. In the coastal area, a large part of the lower land is artificially created or reclaimed land. The Kanmon Channel links the Sea of Hibiki and the Sea of Suou. The average temperature is around 16.4^{o}C with the highest being about 35^{o}C in July and the lowest being about 3^{o}C in February. Annual precipitation is about 1850 mm. The population initially grew rapidly but later declined; it is now about 1.02 million (1993). The gross regional product of Kitakyushu in 1991 was 2.7 billion yen (0.8% of GNP of 340.6 billion yen) and the share for tertiary industries was 57.4% of the city's total output in 1993, while the share of secondary and primary industries was 41.6% and 1.0% respectively. Steel, chemicals, general machinery, food, and electric machinery are main manufactured goods; however, emphasis on high-tech industries and general and precision machinery is growing.

1.1 Economic growth through industrialization and its environmental impact

Similar to today's situation in most developing countries, Kitakyushu was aiming to boost economic growth by industrialization following World War II. A national income-doubling program was decided on in 1960 and measures to promote high economic growth were taken. The five cities of Kitakyushu area boosted the economy by inviting heavy industries. Kitakyushu had established itself as a center for the cement industry, combining high quality limestone produced in the area and Chikuho coal. After operations got underway at the government run Yawata Steel Works, large-scale factories sprung up in the area around Dokai Bay, forming the framework of the Kitakyushu Industrial Zone. The period of high economic growth was an ear of heavy chemical industrialization and remarkable development of heavy and chemical industries such as steel and machinery. This boosted the economic growth at an average rate of 20% per annum till the first oil crisis in 1973.

However, this industrialization was the main source of the pollution. However, this pollution, which began with the "seven colored smoke", was initially the symbol of prosperity (UNDP 1996). In the late 1950s, air pollution in the form of smoke and soot, offensive odors, and water pollution from factory wastewater grew serious in various locations. Air pollution was mainly due to heavy concentrations of NO_x, SOx, suspended particulate matters (SPM), dust fall, and non-methane hydrocarbons (NMHC) in ambient air. Water pollution was mainly due to presence of toxic substances in industrial wastewater, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were causing river and sea pollution, and Organic-chlorine Chemical Substance was contaminating ground water reservoirs in the area. Moreover, there was noise and vibration, offensive odors, land subsidence, soil contamination, and industrial solid waste including slag, construction material, and sludge.

The increasing pollution was causing devastating impact on humans and other natural resources. For example, the right to fish inside Dokai bay was abandoned in 1956 due to water contamination. The residents around the bay started complaining of odor, and the lives of the ships anchoring in the bay became short. Eventually this bay was known as the Sea of Death. Air pollution cause major health impacts, although, most of those impacts were not known during that time, but Kyushu University's survey showed many adverse impacts, especially on the children.

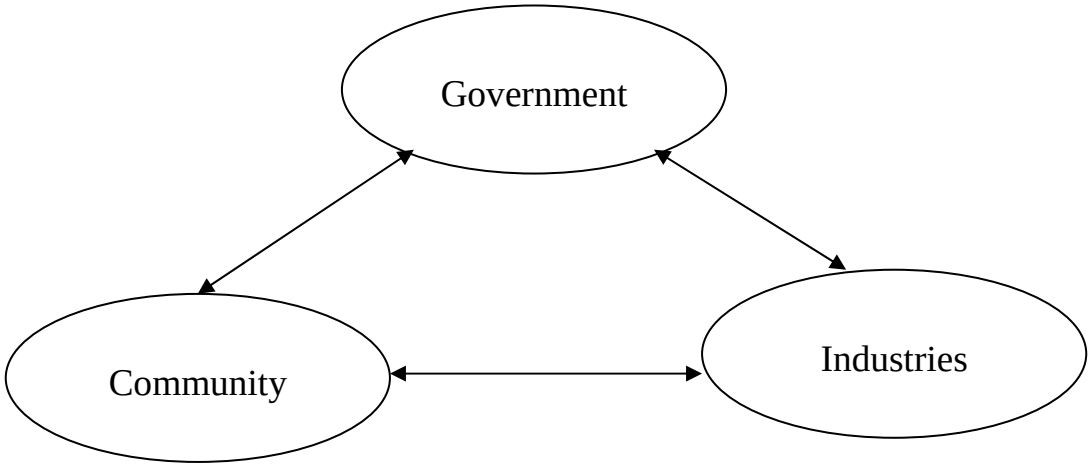
2 Pollution management

2.1 Community, local government, and industries

When the impact of pollution became evident on health, natural resources, and the living environment, the implementation measures were required to control the pollution. However, similar to the existing situation in most developing countries, it is not a common practice that industries can realize the impact of the pollution on their own and can take the necessary pollution control measures. Therefore, the roles of all three major actors - community, local government, and industries - are crucial for pollution management. In Kitakyushu City, this role is a good example for the existing situations in developing countries.

Based on the current research by Aoki (2001), we can draw a triangular relationship between these three actors, as follows:

Fig. 2 Public-Private-Community Partnership



In Kitakyushu city, the community had a very important role to play, as most of the community was either directly employed by the polluting industries or was doing business with those industries. Hence, they did not want to make these industries relocate or to take any adverse action. On the other hand, the community also wanted the industries to take measures against pollution. Hence, various women's groups were formed, which include Nakabaru Women's group and Tobata Sanroku Women's Group. First, these groups carried out the studies on the impact of the pollution, and then started raising public awareness by showing those impacts. This public awareness mounted political pressure on the local government to respond. Fujikura (2001) suggests that the fear of losing elections was one of the major factors for the local government to negotiate pollution control measures with industries. Industries also did not want the government to lose the elections, as the other parties may place more stringent laws on the industries. Hence "voluntary agreements" were worked out between the government and the industries.

This clearly shows the initial role of these three actors. Later actions also involved all three actors, as the communities also had to cooperate with the government and the industries for various pollution control measures, i.e. relocation of households and industries. The local government needed to improve its capacity to monitor pollution, and the industries needed to take some innovative pollution control measures, which may not harm their economy while improving the environment. The last two issues, capacity of local government and innovative measures by the industries, played a very important role in effective pollution management.

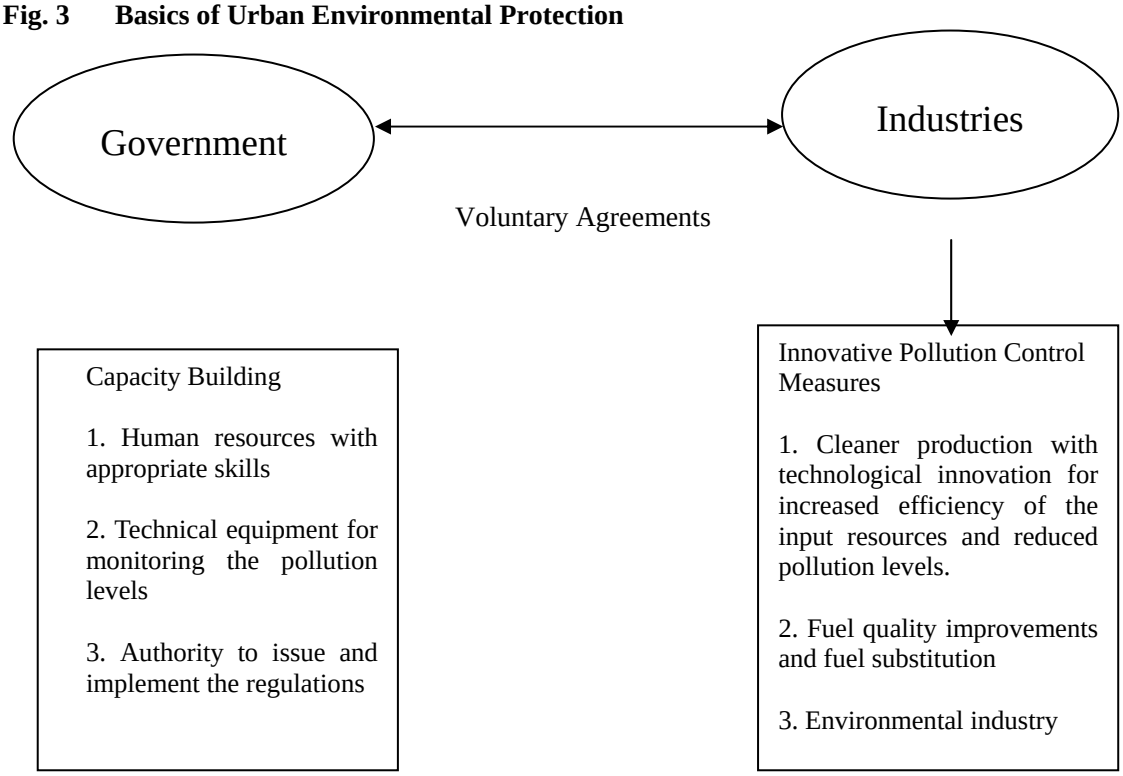
2.2 Capacity building of the local government

Capacity of local governments is the primary issue for pollution management, as governments are responsible for formulation and implementation of regulations. Hence, their authority and jurisdiction, organizational structure and human resources with appropriate skills, and availability of the technical equipment for the monitoring of pollution level are the prerequisites for an effective pollution management system. O'Conner (1994) assesses the environmental management with industrialization and points out that in most Asian countries, the capacity of the governments for environmental management had not been in line with rapid industrialization. He shows the quantity and quality of human resources, and the availability of the technical equipment, which lags behind developed countries like Japan.

In Kitakyushu city, the authority was transferred to the local government from the prefectural government. With this transfer of authority, the city had the jurisdiction to formulate and implement

various regulations, which were initially based on voluntary agreements. The government also had the authority to fine or punish the polluters, who violated those regulations. The government also strengthened their capacity by increasing the number of human resources with appropriate skills and also by acquiring technical equipment to monitor the pollution.

Fig. 3 Basics of Urban Environmental Protection



2.3 Innovative measures by the industries

It is a common belief with industries that environmental measures are costly and hamper profit margins. However, in most cases where innovation is involved, the situation can be reversed, as industries can improve the profit margins by increasing the efficiency of the inputs, by savings on the fuel consumption, and by savings on the end-of-pipeline measures or by savings in paying pollution levies. This approach is widely covered under the umbrella of “Cleaner Production”. This includes cleaner technologies with less pollution, efficient technologies with higher input-output ratio of production, cleaner fuels, and cleaner production practices.

In Kitakyushu City, initially end of pipeline measures were introduced; however, most of the success was due to cleaner production including fuel quality improvements and fuel substitution. This not only helped towards environmental improvements, but it also helped industries to improve their production efficiency and to increase profit margins. Hence this was a real “win-win situation”. In addition to this, environmental businesses started in the city and environmental industry came into existence. This further helped the city to boost the economy.

This Kitakyushu model is almost similar for all industrial pollution; however, due to limited space, we will analyze this model for Kitakyushu City’s experiences in SOx pollution management and its transferability for the existing situation in the cities of developing countries.

3 Kitakyushu City’s achievements for SOx pollution control

SOx pollution was one of the major sources for causing health damage including chronic bronchitis (persistent cough) and asthma (Kochi et al. 2001). SOx pollution related health savings due to control measures have been estimated as 15029 billion yen between 1968 and 1973, and 9409

billion yen between 1974 and 1983 (Kochi et al. 2001).

Japan's measures to control SOx pollution have been commended internationally as successful efforts to dramatically control sulfur emissions (OECD 1977). The Metropolitan Environment Improvement Program (MEIP) has recommended the same type of measures for developing countries (UNDP 1996). Among Japanese cities, Kitakyushu City's measures to control SOx pollution have been certified by various agencies, as Kitakyushu City has won various international awards.

This case study is aimed to analyze those measures for their replication in developing countries. The next section briefly introduces Kitakyushu City and its achievements for SOx pollution control. The third section discusses the important measures and the possibilities for their replication in the cities of developing countries. The final section concludes this case study by highlighting the implications for SOx pollution control measures for developing countries, by learning from the experiences of Kitakyushu City.

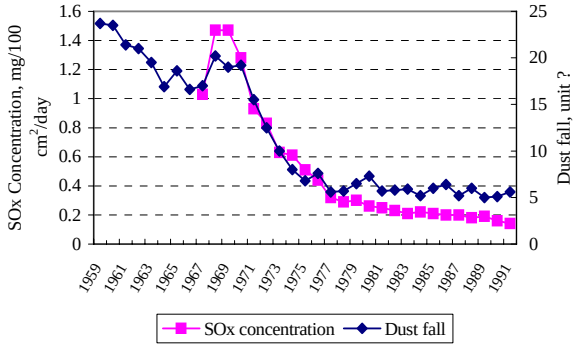


Fig. 4 SOx concentration and dust fall

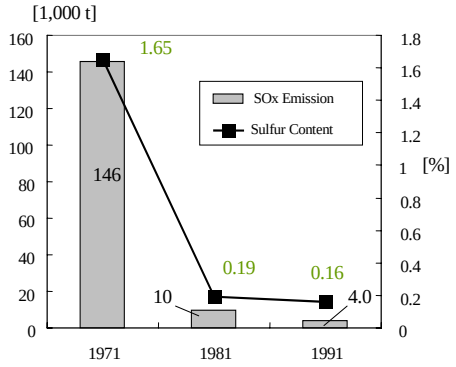
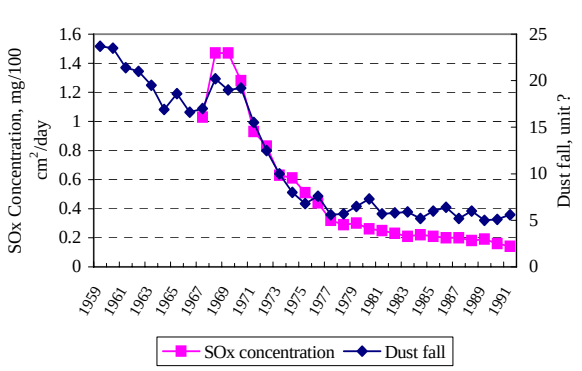
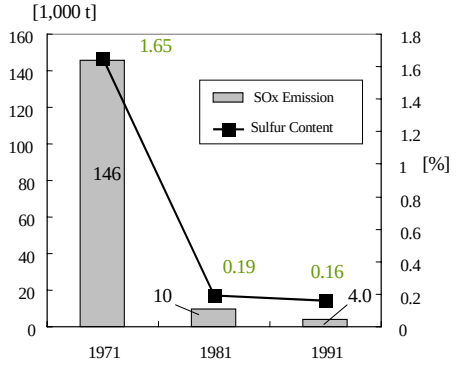


Fig. 5 SOx emissions and average sulfur content of fuels

3.1 Measures for SOx pollution control

The motivation for the local government to act in improving SOx and dust, in particular, goes back to women's protest movements that started with the slogan "we want our blue sky back" in the mid 1960s. Such campaigns increased awareness among people who were silent for a long time towards the negative aspects of environmental pollution. Despite pressures from polluting enterprises, these women groups petitioned and challenged the local government with their own studies on air quality. In other cities in Japan such as Kawasaki, and Osaka, citizen groups had a number of confrontations with the polluting enterprises and the local government. The anti-pollution movement had political repercussion in those cities. The motivation for local political leaders to carry out the anti-pollution measures had some political consideration because of the leftist political





party's active environmental agenda and ongoing public awareness and protests for environmental improvements. This provided motivation to polluting enterprises to seriously cut emissions. The situation led to the voluntary agreement (March 1972 and January 1977) between polluting enterprises (48 companies, 57 factories) and the

local government to reduce emissions and to implement pollution control measures. These two agreements were made in groups; however, individual agreements were made a number of times.

The countermeasures against air pollution by the city government can be divided into the following themes:

Strengthening of local regulations
Enhancing institutional capacity
Fuel quality improvement and fuel substitution
Technical guidance and technology enhancement in the manufacturing process
Change in industrial structure
Financial mechanisms: subsidy measures
Enforcement
Public awareness

3.2 Strengthening of local regulations

Apart from the anti-pollution law of the national government (Environmental Quality Standard, Emission Standard, Area-wide Total Pollution Load Control, and Automobile Exhaust Emission Regulation), Kitakyushu City itself formulated stricter laws, regulations and inspection systems. This included: (1) new plant modification order, improvement order, and stricter inspection to smoke and soot treatment facilities (2) continuous pollution monitoring and (3) emergency measures (1969-74). The emergency measures demanded the systematically reduction of SOx emissions by 20%, 30% and 50% from industries in the implementation period. Local regulations also included time and quantity reductions. For time regulations, a weather information system was developed for smog warnings and for special weather events that would aggravate pollution concentration. Once the smog warning was issued, individual industries had to follow the assigned quantity reduction for the designated time period. The K-Value[2] regulation, in which the emission quantity was regulated by the height of the exhaust port, was set at 1.75 for Kitakyushu, which was the second most strict in Japan. Market based instruments (MBIs) were also tried, which included the health compensation law of 1974, where industries would compensate people who became sick due to SOx pollution.

3.2.1 Application of environmental regulations in developing countries

In Kitakyushu City, regulations began as “voluntary agreements” between industries and the local government. Hence, this aspect is very important for cities in developing countries, if there could also be an initiative with “voluntary agreements” to control the pollution. These “voluntary agreements” later became mandatory agreements or regulations.

Environmental regulations, which are usually termed as Command and Control (CAC) measures to control pollution were widely applicable in most developed and developing countries, as those were comparatively easy to manage by the administration (Matsuoka 2000); however, economists are now promoting market based instruments (MBIs), which are economic incentive based measures, to increase the efficiency of resources (Turner et al. 1993). However, efficiency of MBIs and CAC depends on ground realities and the type of measures. For example, under CAC, we may choose among technological standards, emission standards, or production standards. Here, emission standards give liberty to the polluter to use the best measures for optimizing the efficiency of the resources. Moreover, Kochi et al. (2001) has shown that efficiency of CAC was varying during three different phases, depending on various factors leading towards cost-benefit analysis.

On the other hand, efficiency of MBIs depends on the capacity of the administration for monitoring the emission levels and also to draw appropriate pricing, which should be equal to marginal abatement cost. With low level of expertise and technology available in developing countries, the continuous monitoring at source level is difficult. Furthermore, improved abatement and production technology also affects the calculations for marginal abatement costs; thus, it is not easy to keep consistent pricing over the years.

These implications suggest that a mix of CAC and MBIs may be a better solution for developing

[2] In K-value regulation, allowable emission in $Nm^3/hr = K * 10^{-3} * He^2$, where, He is effective stack height in meters, K=1.75 for Kitakyushu.

countries. This means, where CAC measures have been adapted, those measures should be strenghtened, and if there is a need of a new measure, then the possibilities for MBIs should also be explored. However, with improved levels of human resources and technology in the future, coupled with growth of multinationals, it might be efficient to adapt the same measures as in developed countries.

3.3 Enhancing institutional capacity

In order to support counter measures, the institutional capacity of the environmental section, in terms of number of qualified staff, monitoring system and equipment, were enhanced. The table below shows the number of administrative and research staff members since the early 1960s. Similarly, the authority of decision making for regulations and standards, and smog warning was shifted from Fukuoka Prefecture to City of Kitakyushu in 1970.

This transfer of authority to the local body provided opportunities to act quickly and also a sense of ownership among the city council, administration, enterprises and the citizens. After this, the Kitakyushu Air Pollution Prevention Joint Council was established consisting of representatives from the national government, Fukuoka Prefecture and key polluting enterprises. This council played a key role in implementing a wide range of countermeasures. Decentralization of the responsibilities within Kitakyushu City was also a key institutional measure.

Table 1 Human Resources for Environmental Governance

Year	Status	Administrative	Research
1963	Subsection	4	-
1965	Section	8	9
1870	Division	22	17
1971	Bureau	25	21
1977	Bureau	75	45

Apart from the local government, enterprises falling under a criterion were mandated to have pollution control managers whose job was to manage technical and managerial matters related to pollutants. Such managers were required to pass the national qualifying examination.

3.3.1 Application of institutional capacity building in developing countries

Decentralization of authority, including judicial and financial, is the most important factor for building municipalities as effective institutions (Shah 1998). Thereafter, institutional building requires proper human, technical, and financial resources and the institutional framework to optimize the output of these resources. Clear job descriptions with incentives and accountability measures are essentially required (Ostro et al. 1993). The technology to monitor the environment is lacking in most cities and there is no mechanism to generate financial resources to higher expertise and to acquire new technology. In this regard, proper institutional building is required to overcome these problems. However, to get a good start, international cooperation for human resource development and acquiring new technology is vital.

3.4 Fuel substitution and fuel quality improvement

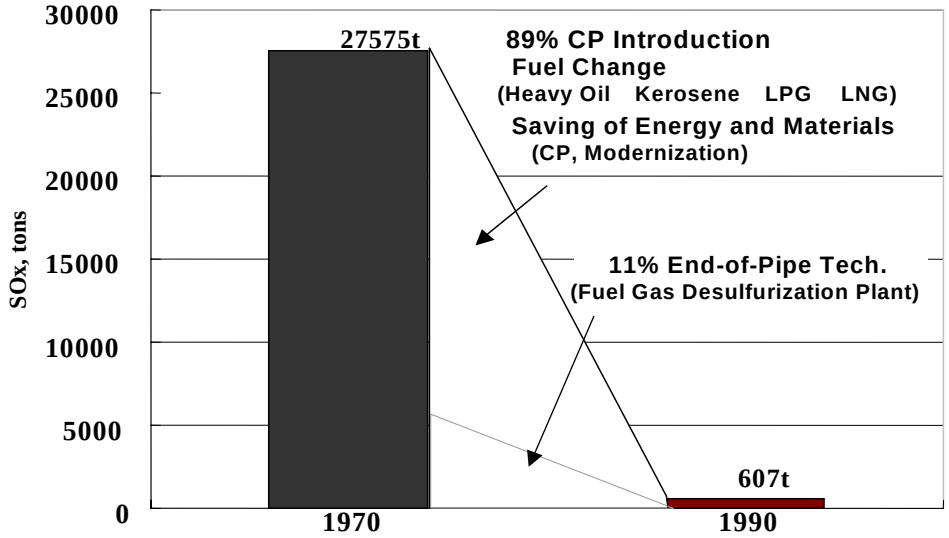
One of the key components of the countermeasures was the type and quality of fuel. The city government had encouraged enterprises to shift from coal based energy system to liquid fuel and then gradually, to natural gas. The figure below shows the consumption of fuels in Kitakyushu. Therefore, the sulfur content per unit of energy consumption was decreased drastically. The process first involved fuel switching from coal to crude oil (sulfur 1%) in 1960s. This was followed by switching to low sulfur content crude oil (0.15%) and light oil, then LPG, LDG and finally to LNG.

3.4.1 Application of energy issues in developing countries

Fuel substitution and fuel quality improvement is a serious concern in developing countries. In most countries, national governments are directly involved in issuing regulations for use of cleaner fuel, but in some cities, local level initiatives are being taken, for example, conversion of CNG

engines for public buses in New Delhi (India) or lead free gasoline in Bangkok. Therefore, fuel substitution is picking up quite rapidly in comparison with other measures, and it can further improve, if municipalities or local governments may obtain legislation powers to ban polluted fuels and to motivate industries, through various incentives, to adapt the technologies with cleaner fuels.

3.5



Imai, S. Undated, Features of Pollution Control in Japan, Tokyo: Japan International Corporation Agency

Fig. 6 Reduction of SOx emissions by various means

Cleaner production technology and end-of-pipe measures

Efficient manufacturing processes can produce large amount of energy saving in manufacturing establishments. The following technology enhancements were carried out in Kitakyushu:

- Process conversion to efficient processes such as in cement kilns
- Raw material switch such as ferric sulfide to sulfur in sulfuric acid manufacturing plants
- Phasing out of small and mid-size boilers and introducing large scale boilers
- Introduction of better equipment
- Recycling of waste energy
- Increased height of the chimney stacks
- End of pipe technology, in particular, FGD (Fluidizes gas desulfurization) installations

The introduction of Cleaner Production (CP) measures was very successful in reducing energy and emissions by large amount. Figure below shows the contribution of CP in SOx reduction.

Know-how and technical support to polluting enterprises by the local government was one important factor. Local government employees, experts and relevant persons on many occasions carried out pollution diagnoses and provided needed technical guidance to manufacturing establishments. This helped in finding appropriate improvement measures. At the same time, such process enhanced the understanding and trust between the government and the enterprises.

3.5.1 Application of cleaner production technology and end-of-pipe measures

Most of these measures are usually adapted by the multinational companies under foreign direct investment, as there are higher initial costs involved. The small industries in developing countries, cannot afford most of the new technology and end-of-pipeline measures like FGD and neither can they run their industries in profit with this spending. This leaves a lot of work to be done by the governments, as only the enforcement of legislations to ban dirty technology will put may people out of jobs and most of local business will come to stand still. Hence, proper evaluation of the socioeconomic impacts of such legislation is necessary to make appropriate changes. For example, the industries may be asked to adapt these measures over time in phases, or there may be some economic incentives for the industries, including tax exemptions and subsidies from the government for the cost of cleaner production technology and end-of pipeline measures. The government may also extend credit or loans for the industries to buy cleaner production technology and environmental abatement technology (This is also covered under the next section).

3.6 Financial mechanisms and subsidy measures

All the activity explained above was not possible without financial facilitation to the enterprises by the local government, particularly, in the case of small and the medium scale businesses. The financial mechanism consisted two parts: (1) public capital financing system and (2) tax incentives. The core of the control measures was technological enhancement and the fuel conversion. So capital needed for the technical countermeasures to be carried out to meet the volunteer agreements and requirements of the regulations were provided at low interest rates. The pay back period depended on the type of companies from 7-20 years.

Table below shows local governmental financing for the air pollution countermeasures of small and medium scale companies.

Table 2 Local government support to small and medium scale companies

1968-95	Number of Cases	Million US$
Air pollution	57	4.8
Odor	19	1.0
Noise	161	15.0
Water pollution	45	3.0
Others	11	0.6

Future considerations in planning process

Tax system benefits were introduced to reduce the burden of expenses necessary for the maintenance and management of pollution control equipment and activities for national as well as local taxes. This included tax exemptions and reductions on fixed assets related to pollution control facilities and equipment, and the extension of applied terms for repayment.

The consideration for the future development was given in the planning process in subsequent years in Kitakyushu by the local government. This includes planning based on future anticipated industrial facilities, scientific analysis of the relationship between source and pollution distribution, support from wind tunnel test/computer simulations, and prediction models.

3.6.1 Application of financial mechanisms and subsidy measures in developing countries

This measure should be in a total package with other measures including cleaner production technology and relocation of industries. However, most developing countries are facing serious financial constraints and it might not be easy for them to provide subsidies. Moreover, the subsidies may decrease the economic efficiency of the resources, as it will distribute the externalities to everyone in the society, which is in contrast to the polluter pay principle. Nevertheless, a proper understanding of the impact of direct tax, based on the polluter pay principle, and subsidies is vital to formulate policies. For example, Kolstad (2000) suggests that without a price system, polluters do not “see” the damage caused by the pollution they emit and if polluter pays a price for every unit of pollution, this corrects market failure, at least in theory. However, Tietenberg (1996) observes that pollution tax may be regressive as higher prices hit poor people proportionately more; therefore, subsidies are progressive to maintain vertical and horizontal equity. Hence, this issue should be dealt on the socioeconomic merit of each city.

3.7 Enforcement

Without enforcement of the regulations and standards, real success cannot be achieved. The inspection systems developed by the local government were: spot inspections, *tele-metering* and routine inspections. The violators were first given warnings and allowed to make needed modifications at two stages and, if proved unsuccessful, leading to fines and imprisonment.

3.7.1 Application of enforcement measure in developing countries

Enforcement of environmental policies is a major challenge in developing countries due to lack of resources and as well as weak institutions. Human resources in local governments are not highly skilled and it is quite expensive to hire outside experts to fill this gap. The technology, including tele-metering system, is not widely available, as the cities lack financial resources. Then, weak institutions further hamper effective enforcement, as conflict resolution and judicial systems takes very long to decide on issues. Political will also changes rapidly with a change in government. Hence for proper enforcement, the institutions should be well equipped with proper technology and human resources, and there should be quick process for conflict resolution along with high political commitment. Moreover, stakeholder participation may help towards effective enforcement.

3.8 Public awareness

In Kitakyushu city, women groups started campaigns to mobilize public support to force industries to adopt pollution control measures. Unlike other polluted cities like Tokyo-Yokohama and Kawasaki, public pressure was weak in Kitakyushu. However, this public awareness provided ground for communist parties to challenge the Mayor of the city. Fujikura (2001) suggests that this environmental friendly agenda led communists to win in other cities, and this encouraged the Mayor and Industries to adapt various “voluntary” measures, as if a communist Mayor may be elected, then that would create more stringent measures for the pollution control.

3.8.1 Application of public awareness measure in developing countries:

In developing countries, public awareness is being raised through NGOs and community groups. This public awareness has helped communities work together to create a better living environment, mainly by managing solid waste and wastewater. However, this public awareness has so far failed to make any major political impact leading towards pollution control policies. The governments in developing countries are rather giving incentives, for polluting their countries, to attract foreign direct investment (Panayotou 2000). Therefore, this type of pubic awareness and public pressure might still take sometime to be effective in developing countries.

4 Conclusion

Kitakyushu City has achieved dramatic success in controlling SOx pollution through various measures. The understanding of those measures helped to classify them among various groups as strengthening of local regulations, enhancing institutional capacity, fuel quality improvement, fuel substitution, production technology and end-of-pipeline options, financial mechanism and subsidies, enforcement, and public awareness.

Based on this classification, we can assess the viability of these groups for achieving similar objectives to control pollution in developing countries. The socioeconomic and political structure of countries is different from each other; hence, a proper analysis of each measure should be done before recommending the same for policy making or implementation.

First of all, a mix of CAC and MBIs could yield better results, as most developing countries are not fully capitalist societies, neither are they fully closed economies. Hence, depending on the administrative capacity and socioeconomic situation, the best policies or regulations could be drawn. Secondly, institutions should be developed with proper human resources, technical resources, and financial sustainability to be capable of policy-making and implementation. Thirdly, fuel substitution and improved fuel quality should be improved by providing proper regulations and incentives. Fourthly, industries should also be encouraged to adapt cleaner production technologies and end-of-pipeline measure in phases, if the industries cannot afford to adapt at once. Fifthly, industrial relocation should be proposed with practical measures, like merging small industries and adapting cleaner technologies. Sixthly, a proper financial mechanism, including subsidies, should be chalked out, which should not distort the economic efficiency of the resources, but rather try to address equity issues. Seventhly, an effective enforcement of the policies is required through a better conflict resolution system and through better human and technical resources. Finally, public awareness to create political pressure for pollution control policies, as it might clash with government's goal to attract the investment.

Nevertheless, a proper understanding of Kitakyushu experiences improves the analytical skills for analyzing the situation in the developing countries. Based on this analysis, proper measures may be drawn for the each city.

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