

## Minamata Disease and Water Pollution Control

Location: Minamata City, Kumamoto Prefecture, Japan

Time Frame: 1956-1990

Programme/Project Status: completed

Background:

In 1959, at Minamata City, where the key industry was fishery, many unknown symptom cases with central nerve system disorder were reported. This disease was caused by methyl mercury and other toxic substance, contained in effluent to Minamata Bay from Chisso Co. Ltd. (chemical products industry, e.g. for acetaldehyde, ammonium etc.) when they were taken into human body through seafood and concentrated by the way of food chains. Although many serious cases were found, due to the lack of scientific information and technological capacity, as well as legal, administrative and social arrangements, as being the first major pollution-related disease in Japan, the counter-efforts including environmental recovery, remedies for patients were delayed. After 40 years it was finally completed to get rid of pollutant substance from the area. However, the case of Minamata Disease and Water Pollution Control may be an example for those environmental recovery efforts without any pre-existing arrangements. Also, the development of environment recovery technology and concurring tremendous investment should be emphasized, as well as national and local government supports.

Measures taken:

Although the counter-measures were taken at late stage after tremendous tragedy, along with national legislation and administration development, many efforts were made. The measures taken in this case can be divided into 5 categories: a) research activities, b) regulatory, administrative, and legal arrangements, c) medical remedies for those suffered from disease, d) improvement of mercury emission system, and f) environment recovery efforts.

As seen in other cases, the first initiative taken was the research activities by an academic institution. Also national and local governments conducted fact-finding survey (however they could not recognize the strong connection between the mercury pollution and Chisso's operation).

Under the pressure by social opinion, Chisso reluctantly introduced improved effluent processing system by times. In 1968 it stopped producing acetaldehyde, whose production process caused mercury discharge.

The amount of mercury discharged and sedimented in Minamata bay was estimated to be 70-150 tons. Since it was feared that mercury would continue to endanger marine environment as well as human health, the Bottom Sludge Programme was launched in 1976. The bottom sludge in Minamata bay seabed was scooped and fed into reclamation sited using a pump specially designed to prevent turbidity in the dredging site. After this process, the reclamation site was covered with non-contaminated mountain soil carefully.

Investment:

48.5 billion JPY (Bottom Sludge Treatment Programme/14 years) borne by Chisso (60%) and the National Government (40%). Also, compensation to those suffered from disease and fishery industry was made by Chisso, Kumamoto Prefecture and the national government. (see Table 3)

Impact:

Effluent-processing system improved by Chisso by several times curbed the amount of mercury discharged into the bay. However, the decisive measure to stop the discharge was to close the acetaldehyde plant in 1968. (see table 1 and 2).

As to the environment recovery effort, mercury contained in the sludge decreased from 25ppm (1977) to 4.69ppm (1990), by the Bottom Sludge Programme.

Changes in the number of Minamata disease patients do not correspond to the time when the abovementioned measures were taken. This seems to be because the time differences

between the intake of mercury into human body and birth of babies with symptom. (See table 4)

Essential Arrangement for the Programme Implementation:

In particular, national and local governments legislation, and administrative and financial arrangement in 1970's supported Chisso's compensation to those suffered and the environmental recovery efforts. Also, law suits conclusion affected to the case positively to some extent. Although they did not directly affected to the mercury emission control itself as envisaged (since they were mainly introduced after Chisso stopped discharging toxic effluent), it should be rather pointed out the Minamata case itself had great impact on the introduction of those legal and administrative efforts.

It is noted that the main reason of delayed control and recovery-efforts was until 1970 the principle of 'burden of proof' was strictly applied in law cases as well as administrative decision, and the concept of 'environmental reversibility' and 'precaution' were immature.

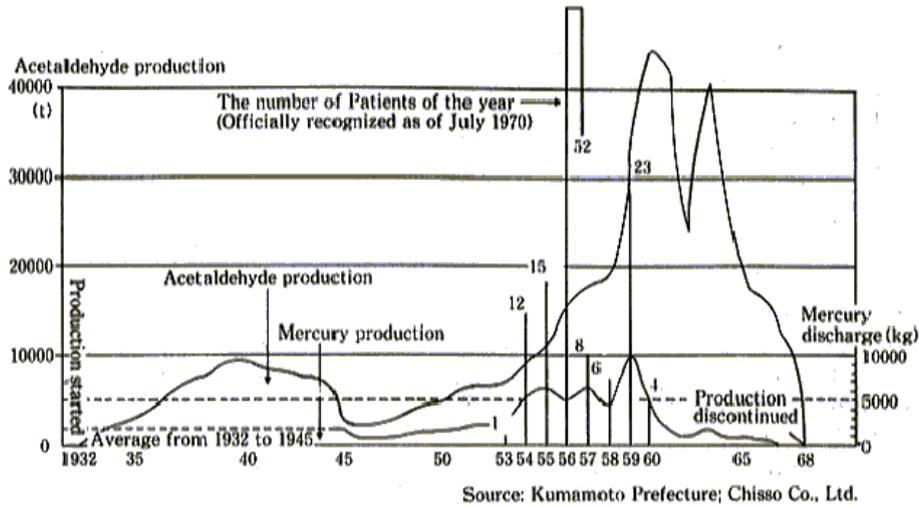
Information Source:

[http://www.icett.or.jp/lpca\\_jp.nsf/](http://www.icett.or.jp/lpca_jp.nsf/)

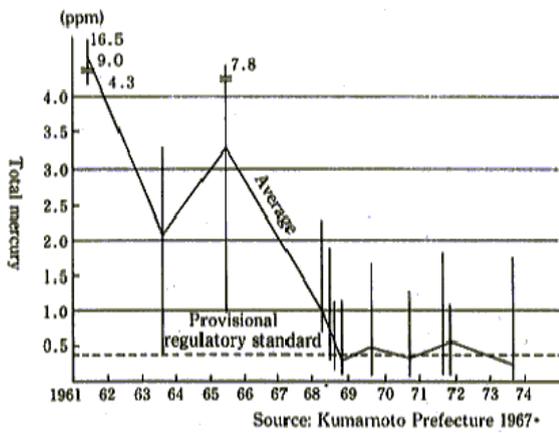
### Chronological Table

Year	Chisso Activities	Research Activities	Regulatory/Administrative/Legal Measure	Medical Remedy	Other Preventive/Recovery Efforts
1908	-Nippon Nitrated Fertilizer Co, Ltd. began operation				
1956		-First Minamata Disease was recognized -Kumamoto University (Medical Study Group), the first investigation report - Ministry of Health and Welfare(MHW), Science Research Group report	- Pref. Administrative Guidance to minimize seafood consumption		
1957	-Iron Chamber Mercury Collection	- MHW , the Special Task Group of the Food and Sanitation Investigation Committee			-Fishing Association's Self-imposed control (until 1964 )
1959	-Circulation and Sedimentation Mercury Collection System				
1960	-Drain Circulation System				
1962		- Medical Study Group reported Chisso' effluent contained organic mercury - Similar Symptom cases were found in Niigata Prefecture			
1965					
1968	-Acetadehyde Plant closed				
1969			- National Government imposed methylmercury discharge control on all plants in Minamata Bay		
1970					
1971		- Kumamoto University started a full-scale health survey	- Law for the Water Pollution Prevention		
1972			- Kumamoto Pref. Issued bond for Chisso's financial crisis		
1973	- Chisso's fishery compensation				- Fishing Association's Self-imposed control (until 1975)
1974	- Chisso's fishery compensation	- Environment Agency, the National Institute for Minamata Disease for Clinical Study	- Pollution-related Health Damage Compensation Law - Minamata City-Chisso Agreement on Pollution Control		
1975			- Fishery Prohibition (until 1990) - Fishery Compensation between Kumamoto Prefecture and the Fishing Association		
1976					-Bottom Sludge Programme launched
1978					
1988					
1990					
1994		- Fish Sample Exam	-Kumamoto Pref. Environmental Education Center		- Pollutant Partition at the mouth of Minamata River

<Table 1> Changes in Acetaldehyde Production, Mercury Discharge, and Minamata Disease Cases



<Table 2 > Marine Products Contamination Trends



<Table 3> Cost for Minamata Disease Control

The costs born by Chisso Co. Ltd., the national government, Kumamoto Prefecture, and Minamata City (Approximate figure)

(1) Damage compensation for pollution-related patients	93.4 billion yen (As of the end of September 1991)
(2) Pollution control operation cost	48.5 billion yen (As of the end of March 1991)
(3) Damage compensation for fishermen	3.9 billion yen (As of the end of March 1991)
(4) Public health protection cost	4.2 billion yen (As of the end of March 1991)
<b>Total</b>	<b>150.0 billion yen</b>

Source: Minamata City

<Table 4> Officially-recognized Minamata Disease Patients, 1969-1992

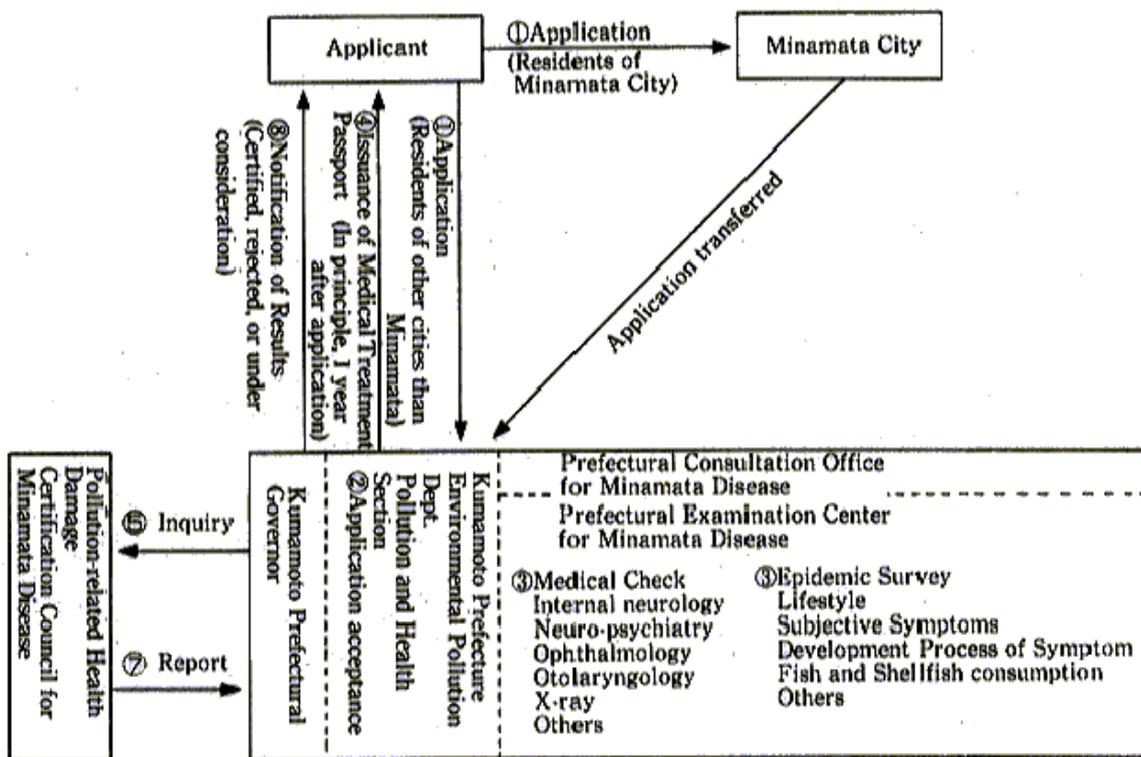
Table 3-1 Officially-recognized Minamata Disease Patients, 1969-1992

Fiscal year	Before regulation	69	70	71	72	73	74	75	76	77	78	79
Kumamoto Prefecture	44	67	5	58	204	292	29	146	109	196	125	116
Kagoshima Prefecture	1	4	0	2	12	66	15	15	39	44	50	27
<b>Total</b>	<b>45</b>	<b>71</b>	<b>5</b>	<b>60</b>	<b>216</b>	<b>358</b>	<b>44</b>	<b>161</b>	<b>148</b>	<b>240</b>	<b>175</b>	<b>143</b>

80	81	82	83	84	85	86	87	88	89	90	91	92	Grand total
48	57	76	46	41	29	44	18	7	2	7	1	1	1768
23	20	19	22	26	25	16	22	12	11	11	3		
71	77	95	68	67	54	60	40	19	13	18	4		

As of March 31, 1992  
Source: Minamata City

<Table5> The Process of Official Designation of Minamata Disease Patients



Source: Minamata City

## **The Ecology: A 'Natural Kidney' for Urban Wastewater in Calcutta**

Location: Calcutta, India

Time Frame: 1980(when an official research conducted)- onwards

Programme/Project Status: ongoing (midterm evaluation available)

Background:

An ideal wastewater treatment system, as in cities in developed countries, has facilities for the whole process from wastewater collection from each household to automated water treatment, before it release collected waster to surrounding natural water bodies. Although such a system is, without any doubt, the best way to avoid water quality of local environment, it is always a serious issue to establish and maintain expensive facilities, especially in the context of cities in developing countries. Under such a difficult financial circumstances, wastewater treatment issue of many developing cities are stagnant, or in some case, in a dead-rock situation\*. The case of Calcutta Metropolitan Authority may provide a unique perspective to solve these issues, when a given local government has financial constraints in introducing a modern wastewater treatment system.

\* Providing foreign financial aids may be an option to introduce or upgrade modern wastewater treatment facilities. However, it should be noted that this method may be very expensive and, when considering sustainability, suitable only for local governments without not so serious financial constraints in the maintenance of the provided facilities and personnel.

Measures taken:

Calcutta has a huge marshland in its east part. The Government of West Bengal and the Calcutta Metropolitan Authority developed a three-part strategy for the reuse of waste-water: vegetables are grown on garbage substrata with treated sewage used to irrigate the garbage farms; next, 3,000 hectares of fish ponds integrate sewage treatment with fish farming - the sun destroys most harmful

bacteria and the fish feed from the ponds; finally, the treated sewage is used to grow crops. Through this process, all the sewage from Calcutta is treated, the garbage fields produce 150 tons of vegetables per day, the fishponds produce approximately 8,000 tons of fish per year, and the paddy fields produce 16,000 tons of winter paddies. The project is managed by community groups, utilizes appropriate technology, with entrepreneurs taking away all sales proceeds in return for rental of land and water.

#### Impact:

Since the region is suitable for using solar radiation and improving wastewater quality, each hectare of a shallow water body can remove about 237 kg of BOD per day. In winter, the clearness of the sky is satisfactory (about 90 per cent) for carrying out biochemical activities in water purification. While sewage entering the ponds contains, for example, up to 10 million *E.coli* bacteria per milliliter, in the water released from ponds this figure is a low 10 to 100 per milliliter. Local residents use the released water for bathing and cooking, yet when a 1984 epidemic of *shigella* dysentery swept the region, not a single case was reported from East Calcutta.

It is also recognized that as a consequence of water purification process, in conjunction with fish farming, many of local residents are benefitted financially.

#### Essential Arrangement for the Programme Implementation:

Although Calcutta case may be applicable only to those cities with huge water bodies surrounding them, it is often pointed out many Indian local governments are interested in it. Also it should be pointed out, in this case wastewater included only organic matters basically\*, so that waste substance decomposition can be done in the 'organic process,' such as bacteria biochemical activities and fish farming.

\* In most South Asian cities, wastewater from households do not contain chemical substance, in contrast those in East, and Southeast Asian cities.

#### Information Source:

<http://www.oneworld.org/patp/index.html>

<http://www.bestpractice.org>

# **Fuyan Chemical General Works Cleaner Production**

Location: Fuyan City, Anhui Province, China

Time Frame: 1996-onwards

Programme/ Project Status: ongoing (midterm evaluation available)

## **Background:**

The Fuyan General Works was selected as a demonstration for the China-Canadian Cooperation in Cleaner Production, initiated in October 1996 with financial support from the Canadian International Development Agency (CIDA). As is typical of fertilizer plants in China, the facilities generated large amount of water pollution substance, especially ammonia and sulphur. This project presents a prototype of successful environmental practice in the field of Cleaner Production, conducted under the strong partnership between the two countries. Project bodies include CIDA (Canadian side), the State Economic and Trade Commission (SETC), the State Environmental Protection Administration (SEPA), the Anhui Provincial Economic and Trade Commission (AHETC), the State Administration of Petroleum and Chemical Industries (SAPCI), the State Bureau for Light industry (SBLI) (Chinese side), PricewaterhouseCoopers, Lavalin and ESSA Technologies (consultants),

## **Measures taken:**

The project team (Chinese and Canadian Technical Team) sent engineer and process specialist from the consultants to undertake an on-site CP audit\* with full participation of plant and manufacturing staff. Under this research activity some process flow diagrams were formulated, including the following recommended steps to be taken;

\* (The audit found 60% of pollution was due to the loss of ammonia to the air and to the sewer)

- Engineering and equipment specification in a joint work by the Canadian and Chinese Technical Teams.
- Cost estimating for equipment, civil, structural and electrical by the Chinese Technical Team.
- Preparation and issuing of tender documents for the fabrication of equipment.
- Selection of bids and purchasing of equipment
- Civil, structural and electrical work at the plant personnel.

Also, in order to further facilitate the substantive activities under the partnership between two countries, a guideline was prepared based on the Technical Team Recommendation.

As to technological aspects, the measures were taken in the Table 1.

Table 1 Fuyan General Chemical Works List of CP Measures Implemented under the China-Canada Cleaner Production Project

Stream Number	Stream Identification	CP Measures	Goal of CP Measure	Cost Category
1	Air emissions of ammonia from the mother liquor tanks	Collect air emission; and direct to a wet scrubber	Reduce atmospheric emissions. Improve occupational health. Recover ammonia from air to liquid	Low cost
2	Air emission if ammonia from the bagging operation	Ventilation air collection and scrubbing of the air at the wet scrubber	Reduce atmospheric emissions. Improve occupational health. Recover ammonia from air to liquid	Low cost
3	Scrubbing liquor	Recycling at other process unit	Prevent discharge to sewer	Low cost
4	Bled from integrative tower	Recycling at other process unit	Prevent discharge to sewer	Low cost
5	Bleed from removal	Recycling other process units	Prevent discharge to sewer	Low cost
6	Bleed from isobaric absorber	New equipment for the concentration recovery and reuse of ammonia	Prevention discharge to sewer. Recover ammonia. Reduce Raw material. Generate revenues.	Medium cost
7	Supernatant from sulphur wastes at the gas dsulphurisation area	New equipment for the recovery of sulphur, extraction and recycling of diluted ammonia	Convert sulphur waste into saleable products. Reduce loses of ammonia to the air. Prevent discharge of ammonia to sewer.	Medium cost
8	Ammonia condensate from the collection of contaminated air at the bagging area	Manual collection of the condensate before it reaches sewers; return to recovery	Prevent discharge to sewer. Recover and reuse of ammonia	Zero cost

The cost for the measures incurring 'Medium cost' shown in the above table was born by CIDA.

Impact:

As a result of the measures taken, the following positing impact was found.

<b>No and low cost ammonia measures (initiated late 1997)</b>	
Reduction in losses of ammonia	1,400 tones/year
Recovery of hydrogen in equivalent NH	1,400 tones/year
Net revenues generated	1.8 million RMB/year
Increase in production	+3% per year
<b>Medium cost measures (initiated late 1999)</b>	
<b>Ammonia Recovery Unit</b>	
Ammonia recovered	4,400 tons/year
Reduction in water consumption	8,400 tons/year
Money saved (net)	3.1 million RMB/year
<b>Sulphur Recovery Unit</b>	
Ammonia recovery	270 tons/year
Sulphur recovered	550 tons/year
Reduction in water consumption	29,000 tons year
Money saved (net)	0.34 million RMB/year
<b>Oil Recovery Unit</b>	
Oil recovered	120 tons/year
Money saved	0.20 million RMB/year
Cost of 'medium cost' measures	approximately 1.666 million RMB for three CP solutions
Time to recover cost:	less than 1 year

Also, it is reported that in the first year of implementing zero and low-cost CP measures, production increased three percent, with saving of 15 million RMB. The plant used less raw material and generated less pollution.

#### Essential Arrangement for Programme Implementation:

The present project was based on the agreement between the Chinese government and Canadian government. For this point, the initiative taken by the local authority is not so strong.

In this case, which was conducted in cooperation between two different countries, the guideline played an important role to provide common principles and understanding among the participants.

#### Information Source:

<http://www.chinacp.com/eng/cpcasestudies/casestudy3.htm>

## **Taiyuan Chemical Plant**

Location: Taiyuan City, Shanxi Province, China

Time Frame: 1994-onwards

Programme/Project Status: ongoing (midterm evaluation available)

Background:

Taiyuan is the capital of Shanxi Province in the north-central part of China, with the population of around 2 million. Being a center of major heavy industry of the country, Taiyuan has suffered from severe pollution. In 1998, Taiyuan was designated as the first pilot city by SETC and SEPA project of 'Promotion Production Demonstrative Provinces' and since it has actively led in this field, by adjusting its economic structure, by its 'blue sky and clear water initiatives. The present case is under the umbrella of the China-Canada Cooperation Project in Cleaner Production

The Taiyuan Chemical Plant produces chlor-alkali, phenol, chlorobenzene, cyclohexane, and hexane acid. It has been using processes and technologies dating from the 1950s –1960s and thus is very inefficient in terms of raw material use and energy consumption.

Measures taken and its impact:

In 1994, with support of CIDA, China-Canada joint project team conducted environmental audit in view of streamlining production process.

Implementation has been based on the no-cost, low-cost and medium cost recommendations from the CP audits, in that order. Investments have been made and modest benefits have been substantial, with short-term returns on investments. For instance, in the hexane di-acid plant, 784,400 RMB was invested for a process improvement, and the cost is estimated to return in 1.37 years. In another example, 877,00 RMB was used for water recycling in the chlorobenzene plant. In one year, more than one million tons of water was saved, (which accounts more than 1,300,00 RMB at net saving).

With regard to the administrative aspect of the plant, it has established a 'special task force' system for environmental production supervision. This structure includes two inspectors and one monitoring personnel for each of the eight hour shifts. Inspector assume responsibility overseeing production controls, environmental control facilities, and discharge while monitoring personnel bear responsibilities for issuing orders to correct deficiencies. They have the additional mandate to issue fines and penalties in case situation is not corrected within a specified time.

#### Essential Arrangement for the Programme Implementation:

The present case is in the context of the series of Taiyuan's environmental efforts. The city government has been active to encourage industrial sector to improve CP methods, with support of the national and foreign assistance. The supportive measures range from promotional to prohibitive ones. In 2000, Taiyuan became the first Chinese city to introduce CP production regulation to guide investment in the city. These regulations provide a framework for Taiyuan to carry our cleaner production, as well as a model for other Chinese cities and provinces.

#### Information Source:

<http://www.chinacp.com/eng/cpcasestudies/casestudy4.html>

## **Chicago Public Housing Buy-Back Program**

Location: Chicago City, Illinois State, United States

Time Frame: 1995-onwards

Programme/Project Status: ongoing (midterm evaluation available)

Background:

As is often the case with big cities in the United States, management of increasing amount of solid waste produced by households is a serious issue. This has been particularly a growing concern, compared with the amount of solid waste produced by business, since the economic growth in past 10 years has accelerated the high resource consuming behavior among consumers. To change such trends, and mitigate its counter effect (i.e.environmental burden), the City of Chicago has launched 'Chicago Public Housing Buy-Back Recycling Programme' in conjunction with other solid waste management programmes.

Measures taken :

The Department of Environment (DOE), the City of Chicago launched the programme for public housing recycling, in cooperation with other organizations\* including those from private sectors. The programme, working with local resident organizations, provide direct payment to CHA residents for recyclable materials collected in their homes and neighborhoods, by recycling trucks on designated days each week.

The programme was late expanded to include all family developments and most senior citizen buildings, involving 10 local youth organizations. This is intended to raise awareness inside households (by families of those children), as well as to provide children with environment education through activities of the youth organizations.

In addition to providing a short-term investment in the Chicago Housing Authority (CHA) developments through the voucher payments, the recycling programme also makes long-term investments in the communities by hiring programme, to integrate low-income group in to the society.

\*Public Sector: Chicago Housing Authority (CHA)

Private Sector: Americorps, VISTA, Resource Center (a local nonprofit recycler)

#### Impact:

By the end of the first year (1995) the programme collected over 60,000 pounds recyclables, which had been automatically disposed as garbage formerly (USD 5,000 were paid by coupons). In 1999, residents from the family units received USD 119,589.04 and senior building were paid over USD 18,000, which represents over 560 tons of paper waste, saving more than nine and a half thousand trees.

#### Essential Arrangement for Programme Implementation:

The present initiative was primarily take by the DOE, the City of Chicago, with provision of miscellaneous support, including financial measure. But the significance of the present programme lies in the partnership between public and private sectors. Since the technique of handling recyclable material was provided by the participating private sector, the recycling activities were able to connect to business activities smoothly.

In case of US cities, those residing in public residence in urban areas often belong to a minority group, socially disadvantaged in terms of educational, vocational as well as financial aspects. In view of this fact, such programmes are being used as an administrative tool to promote their social integration, while seeking for environmental effects.

#### Information Source:

<http://www.cityofchicago.org/Environment/SolidWaste/CHA-ByBackRecycling.htm>

## **Semi-aerobic Landfill / Fukuoka Method**

Location: Fukuoka City, Japan

Time Frame: 1967- onwards

Programme/Project Status: ongoing (midterm evaluation available)

Background:

As in many Japanese large cities, solid waste management has been a major environmental issue in Fukuoka City. Being the largest commercial center of Kyushu island, the population has been continuously growing, which caused increasing amount of solid waste produced and shortage of landfill sites. Also, the administrative cost for solid waste management has become growing pressure to its budget, thus, it was necessary for Fukuoka City to introduce the measure to provide new landfill sites to manage solid waste efficiently well as in cost effective manner. To this end, Fukuoka city launched a joint project in cooperation with Fukuoka University.

Until the invention of Fukuoka Method, either of aerobic method or anaerobic method was used as major landfill process; The former is environmentally friendly but expensive, while the latter was less expensive but more harmful due to the emission of methane gas. In this regard, Fukuoka Method (semi-aerobic landfill method) is significant in reducing cost, while maintaining environmental friendly aspects to some extent.

Measures taken:

In 1967, at the request of Fukuoka City, Fukuoka University has began research on landfill technology to improve the quality of leachate produced, which later demonstrated that decomposition and stabilization of waste in landfill were enhanced by providing oxygen (air) due to microbial activity. Based upon the studies, including one conducted as a pilot project in Shin-Kamata Landfill site, Fukuoka City introduced Semi-aerobic landfill method, as a main solid waste management system, using the following technology invented by the university.

(Technological aspect of the Semi-aerobic landfill method) \*see Table 1 below.

Leachate is collected in a leachate collection pond through properly sized pipes embedded in graded boulders. As the outlet of the main leachate collection pipe is always open to air, fresh air is drawn into the layers thereby introducing an aerobic condition around the pipes (in case of aerobic landfill, in addition to the leachate collection pipes, air pipes are constructed to pump in air into the waste layers to maximize internal aerobic activities). Since leachate is removed as quickly as it is formed, the internal waste layers have lower water content.

The effects of leachate collection pipes in the semi-aerobic landfill are:

- (a) Leachate is drained out as quickly as possible, preventing in the waste material and making it easier for fresh air to penetrate, thereby promoting aerobic condition in the waste layers,
- (b) By promoting aerobic conditions, microbial activity is enhanced and the decomposition of waste is accelerated.
- (c) By embedding the collection pipes in the boulders, the collection pipes are protected from clogging and damage during operation.
- (d) By rapidly draining out the leachate, water pressure on the liner is prevented from building up, reducing the danger of seepage.

For further information in detail on the technology aspect of the method, see Fukuoka City Environmental Bureau, "Towards a Wholly-Recycling Society, The Fukuoka Method – What is the semi-aerobic landfill?", (Fukuoka, 1999).

Impact:

As presented in the basic research by Fukuoka University as well as a pilot project in Shin-Kamata Landfill site, waste decomposition and land stabilization speed was relatively high (see table 2), which made it possible to return the completed landfill sites to other uses in a shorter period. Also, as predicted, the generation of methane gas was reduced (indicator not available) compared with anaerobic method, while the carbon dioxide amount was bigger than aerobic method.

With regard to the financial aspect, since the structure of Fukuoka Method landfill is quite simple and does not require to use special equipment other than leachate collection pipes,

the total cost is relatively small compared with aerobic landfill.

#### Essential Arrangement for the Programme Implementation:

The essential element of the project success is the technology support provided by Fukuoka University. The cooperation between university and the city government was effectively conducted to operationalize the newly invented technology, maintaining a practical perspective to the environmental administration. Also, the cost-effectiveness of the method may be the distinctive character of the programmes. From the point of view of environmental protection, the method is not the best way (especially when compared with aerobic method), but can be the better way and provide a practical choice for those with financial constraints to manage solid waste issues. This aspect is also related with the essential elements for the successful replication in other project sites (see below).

#### Replication Practice in other programme/project sites:

Since the Ministry of Health and Welfare Final Waste Disposal Guidelines includes Fukuoka Method Semi-aerobic landfill as recommendation, the method has been widely adopted by many local governments throughout Japan.

Also, Fukuoka City has been conducted international cooperation jointly with Fukuoka University in transferring the technology of the semi-aerobic landfill to Asian cities. In particular, the City of Tehran, Islamic Republic of Iran (in cooperation with UNCHS), Seberang Perai, Malaysia (in cooperation with JICA), Ipoh, Malaysia, and Guangzhou, China successfully replicated the Fukuoka Method. Again, although Fukuoka Method has a shortcoming in the rapidly bigger amount of carbon dioxide through its decomposition process, it is more practical than total aerobic landfill method in cost effectiveness, and more environmentally friendly than anaerobic landfill in smaller amount of methane gas as well as the speed of the decomposition process. Furthermore, the method does not require any complicated material or maintenance technique. These are the main reasons why the method has been widely accepted by other local governments.

#### Information Source:

<http://kankyo.city.fukuoka.jp/gomi/shisetsu/saisyu3.htm> (Japanese only)

Fukuoka City Environmental Bureau, 'Towards a Wholly-Recycling Society, The Fukuoka Method – What is the semi-aerobic landfill?', (Fukuoka, 1999)

Table 1. Structure of Semi-aerobic landfill

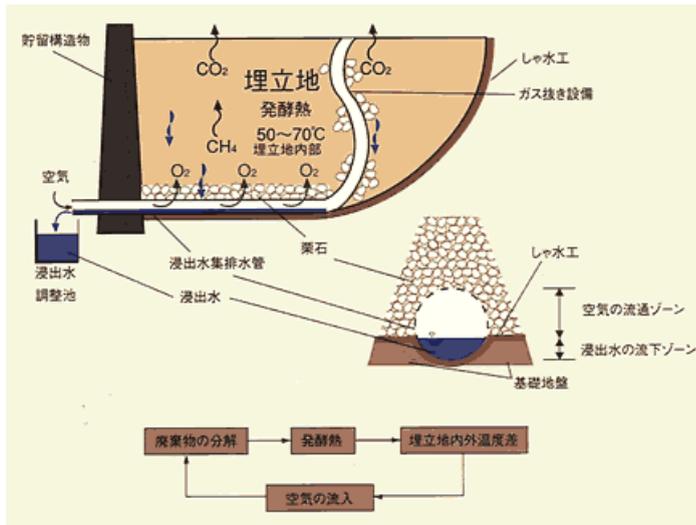


Table 2. Landfill type and change in leachate BOD over time (BOD concentration by mg/l)

Type of Landfill/Elapsed time after landfill (year)	0 year	0.5	1	1.5
Aerobic Landfill	100,000	10,000	10	-
Semi-aerobic Landfill	100,000	10,000	100	-
Anaerobic Landfill	100,000	100,000	100,000	100,000

Source: Fukuoka City Environmental Bureau, 'Towards a Wholly-Recycling Society, The Fukuoka Method – What is the semi-aerobic landfill?' (Fukuoka, 1999), p5.

## Volume-based Collection Fee System of Solid Waste

Location: Incheon City, Republic of Korea

Time Frame: 1995-onwards

Programme/Project Status: ongoing (midterm evaluation available)

Background:

Incheon Metropolitan Area is an international trading port located in the middle-west coast of the Korean Peninsula. Being a growing center of land and maritime transportation in Korea, the population of the city rapidly increased from 1.4 million to 2.2 million during the period of 1985-1994 (59% increase). Although the city has the largest land area in major Korean cities (954 km<sup>2</sup>) and a possible option for building new landfill sites to meet the management need for concurring solid waste increase, the reduction of its amount became an essential measure to be taken for the solution of the root causes.

Measures taken:

'Volume-based Collection Fee System of Solid Waste' was a measure taken as a part of the 'Green Incheon 21 Programme : Making Incheon Clean.' According to this programme, the overall timeframe was set, consisting three stages; a ground pitting stage (1995-1997), a development stage (1998-2000) and a maturing stage (2001 onwards). To reduce the waste amount produced by household, the city introduced the obligatory use of standardized plastic bags for solid waste collection.

To support the reducing waste amount produced by each household, additional component measures were conducted. 16 high speed fermentation processors were installed and 2,065 fermentation processors were distributed for household use. Also, seven centers for the treatment of reusable waste were established.

**Impact:**

By introducing the obligatory use of plastic bags, the amount of solid waste produced by household greatly decreased (see table blow). At the end of 1995, the use of the plastic bags reached a level of 99 %. Also, the revenue from the collected fee increased from 3,179 million Won (US\$ 4 million/ first half of 1994) to 9,349 million Won (US\$ 11,6 million), which means an increase of 195%. This revenue increase made it possible for the Waste Control Division to become self-supporting and to construct re-treatment facilities.

Amount of Total Quantity of Solid Waste produced in Inchon City( per day/1994 and 1995) and the revenue increase from Waste Fee Collection (comparison between fist half of 1994 and 1995 )

	Before	After
Solid Waste Quantity	2,272 tons	1,598 tons (30% reduction)
Revenue Increase	3,179 million Won	9,349 million Won (195% increase)

**Essential Arrangement for the Programme Implementation:**

To maintain the high-level percentage use of the bag, it is required to prevent illegal discharge of waste. However using such measures only may usually cause higher cost of total program. Accordingly, it is further suggested that the awareness-raising amongst households should be promoted as a supportive approach so that potential cases of breach may be reduced. Also, to provide incentives for household to reduce solid waste, the fee is set to become expensive by increase in its volume.

**Information Source:**

<http://www.hsd.ait.ac.th/bestprac/inchon.htm>

## **JBIC Assistance Project for Metro Manila Traffic Improvement**

Location: Metro Manila, Philippines

Time Frame: 1982-onwards

Programme/Project Status: ongoing (midterm evaluation available)

Background:

Compared with other mega cities in South East Asia, such as Singapore, or Kuala Lumpur, or Bangkok, Metro Manila's traffic network was less developed. Since the city's only means for transportation is automobile (light rail transit system is yet to be introduced), avoiding traffic congestion is of paramount importance for its economy as well as environmental issue. In view of these points, the Japan Bank for International Cooperation (JBIC) has provided financial and technical support with the government of the Philippines and municipal authorities of Metro Manila, in construction of roads to further enhance its traffic situation.

Measures taken:

A series of yen loan projects were conducted in the Metro Manila area as shown in Table 1. Except Project No.10 (Light Rail Transit Construction), all project components were development of roads. It should be noted that in Project No. 5, the Air Pollution Monitoring System was introduced, which enable the authority to comprehend the environmental impact of traffic.

Impact:

According to JBIC Impact Evaluation on Metro Manila Traffic Network (conducted by the third party) Economic Impact (EIRR) was 33% in average (Road construction/ upgrading; 48% and Two-level road construction; 24). Compared with the situation before the project (before 1982) traffic congestion was reduced by 10%. Also it is estimated that the series of projects had a positive impact on mitigating air pollution caused by traffic congestion, with

the reduction of SOX (3%), CO2 (4.2 %), NOX(0.6%), and SPM (1.7%).

Information Source:

<http://www.jbic.go.jp>

Table 1. Series of JBIC Projects for Metro Manila Traffic Improvement

Project	Components and Investments
1 Metro Manila Traffic Control Project	Developed 170 crossing points. Includes hard/soft assistance. Loan Period: 1982-1988 Investment: 3,773 million JPY
2 Radial Road No 10 Construction Project	Developed Radial Road 10 and others Loan Period: 1983-1994 Investment: 5,400 million JPY
3 Loop Road No 3 Construction Project	Developed Loop Road No 3 (9.8km) Loan Period: 1986-1994 Investment: 964 million JPY
4 Radial Road No 5 and Loop Road No 4 Construction Project	Developed Road No 5 and Loop Road No 4 (18.957km) Loan Period: 1988-1997
5 Metro Manila Traffic Control Project	Provided 127 Traffic Signs, Traffic Monitoring Cameras (CCTV) and Air Quality Monitoring System. Loan Period: 1988-1995 Investment: 4,447 million JPY
6 Metro Manila Trunk Road Project	Constructed and upgraded 2 Trunk Roads Loan Period: 1989-1998 Investment: 3,296 million JPY
7 Two-level crossing Roads Project (1)	Constructed Two-level crossing Roads Loan Period: 1990-1998 Investment: 2,276 million JPY
8 Two-level crossing Roads Project (2)	Constructed Two level crossing Roads Loan Period: 1991-1998 Investment: 1,512 million JPY
9 Road Pavement Upgrading Project	Road Pavement (34.2km) and upgrading of drainage Loan Period: 1991-1998 Investment: 1,258 million JPY
10 LRT 1 Development Project	Introduction of New Trains and upgrading of lines Loan Period: 1994-ongoing Investment: 8,706 million JPY

# Singapore's Transportation Policy

Location: Singapore

Time Frame: 1970's - onwards

Programme/Project Status: ongoing (midterm evaluation available)

Background:

Singapore has a total land of 645.5 square kilometers and populated 3.15 million. When it was independent in 1965, as other Asian big cities today, traffic congestion was severe, causing a big economic and ecological damage. Under this circumstance, providing effective land-use and transportation system has always been a priority issue for the country's economy. Furthermore, due to the limited space, building new roads was not a possible option (15% of total land has already in use for roads). As a consequence, the government has taken miscellaneous measures to manage to provide excellent mass transportation, and restrict the car possession, which have successfully avoided traffic congestion.

Measures taken:

## (1) Provision of Public Transportation System

The government's transportation policy\* has conducted in conjunction with the Master Plan for Land-use established in 1971, which articulated the provision of Mass Rapid Transit (MRT). Currently Singapore has 2 lines of MRT (83 km, 48 stations), 1 line of Light Rapid Transit (7.8km, 14 stations) for suburban area, 3,600 buses (3 companies) and 18,000 taxis (4 companies). Since most population of the city (86%) resides in public housing complex provided by the governments, the flow of population between those residence and working places is effectively controlled, and the above transportation system plays the vital role to support the mass transit.

\* in 1960's the government established the Road and Transportation Action Committee (RTAC) as a cross-cutting committee to effectively tackle the severe traffic issue in concert.

## (2) Car Licensing System

Although Singaporean purchasing power is quite higher, compared with other ASEAN nations, the possession of a vehicle is controlled by the Car Licensing System. Those who wish to purchase a car are required to obtain permission and meet the criteria set by the government. In addition to the administrative permission, possession of a car is usually not a practical option due to the high cost of maintenance

### (3) Road Pricing Scheme

One of the unique but significant components of the government's transportation policy is the Road Pricing Scheme (RPS). In 1975, it has firstly introduced Area Licensing System (ALS) for preventing traffic congestions in the Central Business District. The ALS set Restricted Zones (RZ), where licensed driver are only permitted to enter, by purchasing permission in advance. In 1995, the government also imposed road pricing in 3 major urban highways, where congestion was severe.

Although these systems were quite effective, it had a shortcoming in the administrative cost in regulation enforcements (for avoiding illegal drivers). Also, it was sought to improve the system to set prices by the degree of traffic congestion. For this reason, the governments newly introduced Electric Road Pricing System (ERP). In this system drivers are to pay fee by an IC cash card when entering Restricted Zones. ERP fee changes every 30 minutes by the condition of traffic congestion.

#### Impact:

As a consequence of tremendous efforts in comprehensive manner, Singapore has been managed to control traffic congestion, while maintaining easy transportation access of residents. According to a survey by the government, traffic speed is 20-30 km/h in commercial centers all day and 45-60 km in highways in rush hours. Energy use rate for private / public vehicles seems to be quite low, especially compared with those in other South East Asian mega cities, such as Bangkok, Jakarta, and Metro Manila (data not available). The table below shows the comparison in the number of vehicles registered in Singapore. According to the survey, the total number of vehicle marked only 30% increase in these 10 years, due to the abovementioned government policy. This is also unique amongst South East Asian cities, where the motorization is in trend.

#### Essential Arrangement for the Programme Implementation:

As often pointed out, Singapore has a different context in the urban environment management, since it is a city directly controlled by the national government. Also, due to the limited land space, the governmental control can be easily achieved all over the area under its jurisdiction. For these points, it may not be proper that Singapore's successful cases be transplanted in other project sites. Nevertheless, it should also be pointed out that some aspects of the city's projects might be replicated with a necessary modification. For instance, in connection with the present case study, Tokyo metropolitan government has studied the possibility of introducing Singaporean Road Pricing Scheme, while recognizing the difference in administrative structures between two cities. In this sense, although the measures to be taken and their results of similar projects may not be rigid and clear-cut as those conducted in Singapore, there is a enough room for replication, if fixed with some necessary modification.

#### Information Source:

<http://www.gov.sg>

<http://www.kankyo.metro.tokyo-jp/jidousya/roadpricing/singapore1.htm> (Japanese only)

Table 1.

#### Moving of People and Goods by Land

Year	1989	1999	Increase percent
Total Vehicle Population	521,000	689,000	30%
Cars	271,000	403,000	
Goods Vehicles	128,000	151,000	
Motor Cycles	121,000	134,000	

Source: Dr. Tan Thiam Soon, Associate Prof., National University of Singapore

## **Jakarta's Kampung Improvement Programme (KIP)**

Location: Jakarta, Republic of Indonesia

Time Frame: 1970-1980

Programme/Project Status: completed

Background:

'Kampungs' are the informal, unplanned and, in many cases, unserviced housing area, which can roughly be understood as illegal squatters areas or slums in the context of the present case. In 1960-1990's, inspired by the rapid economic growth of Indonesian economy under the strong leadership of the President Suharto, Jakarta experienced a massive influx of population from rural areas, and squatters formed kampungs around the city. Due to the lack of public service in sewages, garbage collection, and other hygiene-related matters, residents' health and living condition were in extremely bad situation. Also such kampungs themselves gave harmful effect to the urban environment, as in solid waste management, waste water treatment etc. Such is the case in other cities in Indonesia as well as in many Asian Pacific cities, accordingly it may be interesting to take up the present successful case, taking into account of possible replication in future.

Measures taken:

Traditionally, a rigid measure was taken to solve slum issues in Asia and Pacific cities, by 'forced removal' or evacuation. However, such a measure is now understood to be ineffective, merely causing squatters to move to other kampungs. The city government of Jakarta, in cooperation with the national government, and World Bank, sought to tackle a root causes -poverty-, thus made efforts to upgrade residents living standards.

Since 'kampungs' were formed illegally, the city government was unable to support those illegal residents theoretically. Therefore the 'legalization' of such residents was the primary access by the government. In view of this situation, national law introduced a new concept, under which a continuous occupation of a land for certain period would result 'entitlements' for the relevant resident to reside in a given place.

In addition to the legalization measure, the city government financial support residents to upgrade living infrastructure inside kampungs, by ensuring residents ownership (the city government sought financial resource from World Bank loan). Upgraded facilities include roads, footpaths, drainage canals, water supply, sanitation, solid waste disposal, schools and clinics. In this method, community group in kampungs took initiatives in formulating a development plan as well as maintaining the public services.

#### Impact:

As a major impacts of the programme, kampungs houses were greatly improved. Residence, , now have brick/cement walls, tile/terrazzo and cement floors, and tile and zinc roofs, which is less vulnerable to floods or storms than those build with bamboo or wood. In conjunction with housing construction raw sewage/sanitary toilet system was introduced, which contributed to hygiene of the residents.

Swedish SIDA survey shows miscellaneous improvements in comparison between 'pre-KIP' neighborhood and nearby 'post-KIP' neighborhood. Here, in particular, environment and health-related data are cited as tables below. \*

\*cited from McGranahan, G., Leitmann, J., and Surjadi, C, *Understanding Environmental Problems in Disadvantaged Neighborhoods: Broad Spectrum Surveys, Participatory Appraisal and Contingent Valuation*, (Stockholm Environment Institute-SEI/ International Institute for Environmental Technology, and Sweden International Development Agency-SIDA, Stockholm) 1997

#### Essential Arrangement for the Programme Implementation:

The most unique aspect of the present case is the legal measure taken by the national government, which helped the city government taking an initiative to solve the problem, which had been in 'deadlock' situation for long time. Another distinctive feature is the involvement and ownership of the kampung residents. Since such residents belong to the lowest income group of the city population, who newly flew from rural areas, their social integration is a crucial problem. In this sense, the impact of the programme represents environmental, social and economic aspects. This programme has already been replicated in other cities in the country, such as Surabaya and Denpasar.

#### Information Source:

<http://www.nic-nagoya.or.jp/nicaradar0010.htm> (Japanese only)

<http://web.mit.edu/urbanupgrading/upgrading/resources/bibl.../Kampung-improvement.htm>

<http://www.worldbank.org>

McGranahan. G., Leitmann, J., and Surjadi, C, *Understanding Environmental Problems in Disadvantaged Neighborhoods: Broad Spectrum Surveys, Participatory Appraisal and Contingent Valuation*, (Stockholm Environment Institute-SEI/ International Institute for Environmental Technology, and Sweden International Development Agency-SIDA, Stockholm) 1997

Table 1. Drainage and Flooding in an Un-Upgraded and Upgraded Neighborhood

	Un-Upgraded (N=100)	Upgraded (N=100)
<b>Flow of gray water in drains</b>	%	%
Steady flow	71	57
Slow Flow	22	31
Stagnates	6	12
Sweeps into earth	1	0
Total	100%	100%
<b>Floods entering grounds in last year</b>	%	%
None	4	4
1-2 times	30	36
3-4 times	31	32
5-9 times	17	19
+10Times	18	9
Total	100%	100%
<b>Extent of flooding in last year</b>	%	%
None	4	4
Only in yard	15	28
Inside home	81	68
Total	100%	100%
<b>Level of flooding</b>	<b>Sample %</b>	<b>Sample %</b>
Share of homes with evidence of >50cm floods	25	25

Table 2. Solid Waste Handling in an Un-Upgraded and an Upgraded Neighborhood

	<b>Un-Upgraded (N-100)</b>	<b>Upgraded (N-100)</b>
<b>Main indoor waste storage container</b>	%	%
No indoor storage	29	27
Open container	29	34
Closed Container	5	15
Plastic bag	37	24
Total	100%	100%
<b>Main outdoor waste storage container</b>	%	%
No outdoor storage	26	8
Open container	47	71
Closed Container	4	11
Plastic bag	18	7
Other	5	3
Total	100%	100%
<b>Waste Collection Frequency</b>	%	%
No collection at house	47	7
Once or twice a week	26	34
Every day	27	59
Total	100%	100%
<b>Dumping behavior</b>	<b>Sample %</b>	<b>Sample 5</b>
Dump most waste in fields or streams	34	3
<b>Burning of waste</b>	<b>Sample 5</b>	<b>Sample 5</b>
Burn some waste	18	8
<b>Location of most serious sw problem</b>	%	%
No serious problem	39	48
Streets	29	24
Marginal areas	24	27
Own land	8	1
Total	100%	100%
<b>Householders waste separation</b>	%	%
Do not separate out paper or metal/bottles	60	42
Separate out just paper	20	37
Separate out just metal/bottles	5	5
Separate out paper and metal/bottles	15	16
Total	100%	100%
<b>Destination of separated materials</b>	<b>Sample 5</b>	<b>Sample %</b>
Separate out paper or metal/bottles	40	58
Sell at least some	19	36
Exchange at least some	25	20
Give away at least some	12	17
<b>Waste picking at households</b>	<b>Sample %</b>	<b>Sample %</b>
Waste pickers sort through household's solid waste	63	67
Waste picker take paper	42	33
Waste pickers take metal	42	36
Waste pickers take bottles	37	40
Waste pickers take other materials	52	32

Table 3. Indoor Air Indicators in an Un-Upgraded and an Upgraded Neighborhood

	<b>Un-Upgraded (N-100)</b>	<b>Upgraded (N-100)</b>
<b>Principal cooking fuel</b>		
Wood	1	1
Kerosene	94	59
LPG	5	40
Total	100%	100%
<b>Cooking location</b>		
Separate kitchen	52	62
Kitchen with family room	46	35
Verandah	2	3
Total	100%	100%
<b>Ventilation of kitchen</b>		
Bad	39	19
Standard	33	40
Good	28	40
Total	100%	100%
<b>Ventilation of living area</b>		
Bad	24	11
Standard	39	38
Good	37	51
Total	100%	100%
<b>House is humid</b>	<b>Sample %</b>	<b>Sample %</b>
	25	10

Table 3. Reported Prevalence on Health Problems during the Preceding Two Weeks in an Un-upgraded and an Upgraded Neighborhood

	<b>Un-Upgraded (N-100)</b>	<b>Upgraded (N-100)</b>
<b>Among children under six*</b>	<b>Sample %</b>	<b>Sample %</b>
Diarrhea (>3x/day)	28	5
Stomach Ache	37	21
Loose stools	39	16
Fever	59	26
Dry Cough	19	26
Wet Cough	63	33
Runny nose	13	3
<b>Among children under six*</b>	<b>Sample %</b>	<b>Sample %</b>
Diarrhea (>3x/day)	6	2
Stomach Ache	29	19
Fever	32	16
Dry Cough	13	11
Wet Cough	33	12
Runny nose	3	10

\* Households without children under six have not been included.

## **Orangi Pilot Project**

Location: Orangi Quarter, Karachi, Pakistan

Time Frame: 1980-1993

Programme/Project Status: Completed

### **Background:**

In Karachi, government sponsored initiatives to regularize squatter settlements failed because of landowners. While the continuous population influx into Karachi from rural areas has enlarged squatters of low-income group, hardly any adequate sanitation service was provided by the public sectors. Frustrated by this situation, Orangi Pilot Project (hereinafter referred to as OPP), a community-based organization/research institute, began replacing open drainage and installation of underground raw sewage, without which the Orangi quarter suffered from the deteriorating human health environment. Although the project itself is not initiated by the local government nor the central government, rather for the purpose of filling their void, it was later replicated in other project sites involving local governments. For this point, this case may provide some significant insight for dealing with wastewater management in urban areas.

### **Measures Taken:**

Being a research institute, not a funding or project executing agency, OPP itself did not provide any subsidy nor labor input. OPP only provided the community with consultancy in awareness-raising, basic research, planning, monitoring/evaluation (and their concurring costs), supporting documentation and other technical matters. The distinctive features of OPP are based upon its discipline that (1) the project's final beneficiaries must have a strong ownership for its implementation as well as post-project maintenance, (2) provision of subsidy tends to lead community's dependence upon donors and other assistance agencies (cost for building raw swage facilities must be borne by and collected from each household), and for this reason, (3) it

should take time and energy to mobilize and organize the community through seminars, negotiation and frequent communications.

Along this discipline, through active community members, OPP support them to form a consensus that they themselves pay for the building cost. Since the community consists of low-income households, OPP assisted them in minimizing the construction cost, by simplifying facilities to be introduced. This also contributed to making the maintenance process easier.

**Impact:**

As a result, underground raw sewage lines were built as the table below (1981-1993). Also, Mortality Infant Rate (MIR) has fallen in the Orangi quarter at faster rate than those in other settlements in Karachi as well as other cities in Pakistan. It is estimated that IMR fell 110 per thousand live births in 1984 to 44 in 1989\*. Although this cannot be attributed only to the improvement of raw sewage system, it seems to have some positive impact on residents' sanitation and public hygiene.

	<b>total</b>	<b>%</b>
<b>Physical Results</b>		
Lanes with sewer lines	4,974	78.4
Length (in ft.)	1,243,945	
Secondary drains	389	
Length (in ft.)	160,218	
Sanitary toilets	75,776	80.5
<b>Investments (in Rs)</b>		
Sewer lines	17,027,694	
Secondary drains	1,743,503	
Sanitary toilets	38,417,200	

Apart from the project, the municipality constructed metalled/paved way, where there were open drainage and underground raw sewage were introduced. This enabled water supply vehicles to come in the community so that community now has an access to safe/clean water.

\*Reed, R and M Vines, 'Reduced Cost Sewerage in Orangi, Karachi, Pakistan, *mimeo*, WEDC, Loughborough University of Technology, 1992 p.19, cite a source from the Department of Community Health Science, Aga Khan University.

#### Essential Arrangements for the Programme Implementation:

As mentioned, physical and financial parts of project were conducted by the community, while OPP only provided technical, research or knowledge-based assistance. Therefore the consensus and ownership-consciousness of the community were strongly emphasized. Also, it is pointed out that avoiding external funding made it possible to reduce the total cost of the facility construction, as well as community's overly dependence to donor agencies.

Orangi model has been replicated in several project sites in Pakistan, such as Lahore.

#### Information Sources:

[http://www.unescap.org/drrpad/vc/conference/ex\\_pk5\\_opp.htm](http://www.unescap.org/drrpad/vc/conference/ex_pk5_opp.htm)

<http://www.hsd.ait.ac.th/bestprac/orangi.htm>

Zaidi, S Akbar, 'Transforming Urban Settlements: The Orangi Pilot Project's Low-Cost Sanitation Model', (City Press, Karachi) 2000.

## **Urban Slum Improvement in Visakhapatnam**

Location: Visakhapatnam, India

Time Frame: 1988-1995

Programme/Project Status: Completed

Background:

Visakhapatnam lies on the east coast of India, midway between Calcutta and Madras. Between 1971 and 1991 its population trebled from 360 000 to 1.05 million. This rapid increase reflected the city's industrial growth as a major naval base and manufacturing center, the poverty of surrounding rural areas from which many migrate and the high birth rate. However there is an acute shortage of land in the city, which is bounded by hills and sea. Population density is high, with 30 000 persons per square kilometer over much of the city. Despite some industrial prosperity over 200 000 people (40 000 households) live in nearly 200 officially designated slums.

In 1988, the Municipal Corporation of Visakhapatnam, supported by the UK Overseas Development Administration (UKODA), started a major program to improve 170 slums (subsequently expanded to cover 200). This programme included physical infrastructure improvements, improved water supply, public toilets, community centers, primary health care services and educational and vocational training.

Measures taken:

The slum upgrading programmes comprises in the following components.

Land Reform

The land reforms were designated to give slum inhabitants security of tenure and a stake in the slum improvements, and to provide and organized layout of each slum. The MCV purchased land in about 20 slums then in private ownership, planned the 170 slums, allowing 60 square yards per plot, and provided legal tenure, pattas (permanent free land

lease) to the plots.

#### Upgrading and Maintenance of Facilities

Since basic infrastructure for solid waste and waste water were not existed in the slum, in conjunction with the land reform measures, the drainage, public toilets etc. were introduced.

Maintenance of infrastructure is shared between the MCV and the slum communities. The MCV is responsible for replacing worn-out asphalt roads, waste collection and maintaining drains. The slum communities are responsible for cleaning drains and sewers, patching roads, replacing inspection chambers and manhole covers, repairing linkages in pipelines and maintaining community centers.

#### Education and Vocational Training

As a support measure of the slum upgrading programme, education and vocational training course were provided with the slum residents. Although this component is not directly relevant with environmental improvement of the slum, from the point of view of social integration of the residents, which has a vital step to access the issue of and maintain efforts for environmental improvement, education and vocational training course was implemented.

#### Impact:

As shown in Table 1, many more households had secure land tenure in 1991 than in 1988. Waste disposal practices improved, with greater use of dustbins for solid wastes and drains (instead of roads or paths) for wastewater. The risk of flood and fire was reduced.

Such solid waste/wastewater –related practice improvement was also reflected in the residents' health condition. As shown Table 2., through the programme, the number of immunized residents increased. Some items in the table did not show a remarkable improvement or even some negative results, but this is thought to be due to an increased tendency to report disease.

Apart from the impacts substantially related with environment and residents' health condition, other co-benefits can be found in improvement of employment and literacy rate. As is the case with programmes for environmental improvement by slum upgrading, education components is especially important, since one of the most serious root causes of

such issues is unawareness and ignorance of waste management by residents, as well as the lack of infrastructure and financial resource.

#### Essential Arrangement for Programme Implementation:

It is often pointed out that the best way to solve urban environmental issues related slum is, not to remove people, but let them stay and provide opportunity to upgrade themselves. As shown in Jakarta's Kampung case, the present case also took the measure to promote improvements of residents' living environment, without enforced removal. While Jakarta's case introduced a legal measure to entitle residents with rights to live, the MCV used financial measures. Since in this case the occupied land by slum residents mostly belonged to private owners, it was more suitable to purchase the relevant land so that the residents were able to remain in the same place.

#### Investments:

For miscellaneous measures taken, 202.6 Rupee were invested in 1988-1992.

#### Information Source:

Abelson, P., *Project Appraisal and Valuation of the Environment – General Principles and Six Case-Studies in Developing Countries*, (St.Martin's Press, New York) 1996.

Table 1. Housing and environment

Households	1988		1991		Change
	No.	%	No.	%	%
Owing house	533	87.1	542	88.6	1.5
With land tenure	186	30.4	449	73.4	43.0
With pucca houses	182	29.7	339	55.4	25.6
Less than 100 sq. ft	-	34.8	-	19.8	-15.0
More than 200 sq. ft	-	17.3	-	34.1	16.8
Average area sq. ft	144	-	171	-	18.8
With electricity	211	34.5	381	62.3	27.8
With separate latrine	72	11.8	133	21.7	9.9
With tap water	325	53.1	345	56.4	3.3
Using dustbins	108	17.7	282	46.1	28.4
Using drains	368	60.1	529	86.4	26.3
Using traditional fuel	405	66.2	414	67.6	-1.4

Source: Household Surveys, Sarveswara Rao and Ramachandrudu, 1992a

Table 2. Health care and status

Category *1	1988		1991		1988-91 Change
	No.	%	No.	%	%
Tubectomies*2	193	64.1	262	67.2	3.1
Vasectomies*2	106	35.2	106	27.2	-8.0
No delivery problems*3	52	86.7	40	85.1	1.6
Post—natal consultations*3	32	53.3	8	17.0	-36.3
Fully immunized (1-3 ages)	56	24.7	92	82.9	58.2
Persons sick, last 14 days*4	43	1.5	130	4.5	3.0
Persons chronically ill*4	39	1.4	92	3.2	1.8
Households under-caloried*5	55	68.8	53	66.3	-2.5
Children 20% +underweight*6	60	46.7	41	31.7	-15.0

Source: Household Surveys, Sarveswara Rao and Ramachandrudu, 1992a

Notes:\*

1. The first 8 rows are based on 612 households; the last 2 rows are based on 80 households.
2. Percentages in couples.
3. Percentages of deliveries.
4. Percentages of all population.
5. Percentages of households.
6. Percentages of children from 0 to 5 years.