**Kitakyushu Initiative for a Clean Environment**

Project Paper for
Wastewater Treatment in Five Communities,
Nakhon Ratchasima (Korat) Municipality, Thailand

**Objective:**

To improve the water quality of Lumtakong Canal, which passes through Nakhon Ratchasiam (Korat) Municipality.

**Tasks:**

1. To improve public awareness through local campaigns.
2. To improve the level of community participation in project implementation and maintenance.
3. To construct low-cost wastewater plants in two communities by adapting similar or improved local technology from wastewater plants in two communities.

Country: Thailand

City: Nakhon Ratchasima (Korat)

Population: 173,526 (registered), 234,418 (unofficial)

Salient Features:

- Located at 250 km N-E of Bangkok at175-185 meters above sea level, and lies along Lam Taklong river (Figure 1).
- Spread over an area of 37.5 $Km^2$ with southern part designated as army retraction area, northern portion consists of low-lying lands, and railway line divides the province into halves.
- Population expansion along both sides of Friendship highway in both the northeastern and southwestern directions (southwestern expansion is encouraged by the convenience of existing infrastructure, low land prices, non-interference from flood and the relatively short distance.
- Average rainfall is 1,043.1 mm, relative humidity is 71%, and average temperature is 26.9$^oC$ (cooler in Dec & Jan, hot in Apr & May), Monsoon from May to Sept
- Soil is mainly hard rock and mostly composed of sandstone and shale with powder sandstone between the bedding planes. Groundwater aquifers in these rock layers are very important because northeastern region mostly lies under these rock layers. The depth of ground water aquifers is in a range of 20-60 meters.
- The main surface water resource is Lam Taklong River for domestic, commercial, agricultural, industrial, and other water consumption.
- Lam Taklong Dam is located in Sikhi district is a multipurpose dam with a capacity of about 120 million cubic meters.

- Nakhon Ratchasima province land use is earmarked as 12.5% forest area, 68.8% as agricultural area, and 17.8% combined industrial, government, and other use. The survey for land use suggests that 77.92% of the total area was combination of agricultural, forest, and derelict land, while industrial, residential, government land together make 15.11% of the total land. This category is densely concentrated within the city center.

Local Government:

- Nakhon Ratchasima Municipality gained its present status of the local authority in 1935. New Thai Constitution (1997) clearly states that Local Administrative Organization at the Provincial, Municipality, and Village level should be given substantially increased powers for policy formulation, development, management, service delivery, administration and personnel management.
- Nowadays, in Thailand provincial government is regional administration system. The governor was appointed by the central government from ministry of interior, while municipal government is local government, and the city assembly elected the mayor. People over 18 years of age elect the member of city assembly. The term for mayor and member of city assembly is 4 years.
- Now city mayor will be directly elected and city mayor will appoint deputy mayor. Separate elections will be held for member of city assembly.

Development Issues: Nakhon Municipality accepted the concept of “Healthy City” since 1995, and it accepted the concept of sustainable development and “Local Agenda 21” since 1991. Thereafter, the

municipality is working to improve environmental conditions including air, water, and waste in the city.

Environmental Project: Improvement of water quality in Lumtakong canal, which flows through the city centers.

Environmental Background and Issues:

1. Lumtakong canal originates from the dam and flows to Mool River. The length of the canal is 80 km including the 9-km section that passes through the city (Figure 2). In the past (before the mid 1980s) the water from the canal was used to supply to the municipality; however, severe pollution makes it unfit for use. Water quality of this canal at inlet and outlet of municipality boundaries shows a significant difference in pollution levels (Table 1).
2. The major concern for the water pollution within municipality limits is the direct discharging of wastewater from nearby communities in the canal. The communities, living on the canal banks, use small pipes to discharge their wastewater into the canal. The adjacent communities use open wastewater channels to discharge into the canal. Overall 814 households discharge their wastewater into the canal directly. We can observe from the attached graphs (Figure 3), showing various pollution indicators, that water quality worsens downstream, especially when it passes through the municipality limits.
3. Apart from wastewater, communities used to throw solid wastes in the canal, which made it virtually impossible for any aquatic resources to flourish and live in the canal.

Initial Actions:

1. Since June 2000, the municipality has launched an awareness program incorporating public participation and partnership, in which communities are educated on the potential benefits of improving water quality in the canal. A local group was established to clean the canal every Thursday; after the success of this awareness program, the Municipality took over clean-up of the canal. The program was successful in reducing the amount of solid waste disposed in the canal to a large extent. Public awareness is also aimed to pursue the households not to discharge untreated wastewater directly in the canal. This also helped to improve the visual water quality and flow of water in the canal, as water that had previous been clogged due to the build-up of solid waste flowed freely, and a few aquatic resources have reappeared both in and around the canal.
2. Two wastewater treatment plants were constructed for two of the eight communities (Tung Sawang Salaloi Community and Mahachai Community) that discharge wastewater directly to the canal through open channels, using existing technology (Figure 4). These wastewater treatment plants use small plastic bottles as a media (Figure 5). These bottles are housed inside concrete tank. These plants have been successful in reducing the amount of BOD (Table 2)

Remaining Actions:

Wastewater from the five communities, where simple wastewater treatment in not yet available, is still a major problem for canal water, as there was no water treatment system available for those communities and the municipality drainage system was not well equipped to collect and treat the wastewater from community households.

Therefore, the water quality of the canal will be improved through following actions:

1. To build low-cost wastewater treatment plants for rest of the communities.
2. To strengthen environmental awareness among local communities along Lam Takong River.
3. To create environmental education centers in local communities nearby the river.
4. To preserve landscape by growing special native plant species along the river.
5. To enhance local people's way of living in sufficient economy.

Pilot Project under Kitakyushu Initiative:

The most important aspect for wastewater improvement is to create local level low-cost solutions for all the communities. These solutions should be acceptable to the communities, and can generate higher community participation for the implementation and maintenance of those wastewater plants.

Under this pilot project, to improve the water quality in the canal, we can propose simultaneous actions, including the construction of low-cost wastewater plants (similar or improved technology), and community awareness and participation, as follows:

1. The Municipality has already taken existing technology and know-how and has constructed wastewater treatment plants in two communities, as indicated earlier. Under this project, similar or more technology-appropriate plans can be constructed in two additional communities, out of five communities along the canal, following an assessment of the effectiveness of the existing plants at Tungsawang and Mahachai:

a) Samrongchun Community (166 households)
b) Tatako Community (200 households)

The Kitakyushu Initiative will provide information on similar types of low cost and improved wastewater treatment plants. The municipality and communities will review that information to improve their existing plans according to their own satisfaction. Of the two simple wastewater facilities to be constructed, the municipality may build one model plant, making use of improved technology for further improvement in the quality of discharged wastewater.

2. Community awareness and participation is also a focus of this project. This element will further expand the results of previous campaigns and activities, such as the solid waste awareness campaign carried out by the Municipality in 2000. This will also include community participation in implementation of the project, i.e. site selection, monitoring, maintenance, and evaluation.
3. To evaluate the progress and impact of the project, we can define some monitoring and performance indicators. For construction, we can analyze if engineering designs were properly followed, cost is within estimated budget, and the construction was completed within estimated time. Then, we will analyze if the operation and maintenance of the schemes is being carried out properly. If all the wastewater is being flowing through these facilities and if the accumulated solid waste in the open channels is being properly cleaned. The maintenance of the facilities includes the periodic cleaning of accumulated sludge and replacement of the media. The impact of the wastewater facilities can be seen from the reduction in the pollution indicators at the outflow from the facilities and then if that has also improved the indicators of the water quality in the canal.

4. To evaluate the public awareness and community participation, we can assess the number of the participants in the public meetings and community meetings. Then we can assess the difference in the household attitudes, if they have stop throwing solid waste in the canal, and if they are routinely cleaning up the solid waste from the canal. The wastewater discharge including proper cleaning of open channels and construction of proper wastewater outlets from the households will be evident of public awareness. For community participation, we can see if they are actively involved in the planning, construction, and maintenance and operation phase of the wastewater treatment facilities. This can be judged from interviewing those households. Then, if they are properly maintaining these facilities over the years.

Schedule and Cost:

This is a one-year project, from April 2002 to March. To successfully implement the project and then maintain the services over a period of time, the sustainable efforts from the communities are also required beyond one year. The cost-breakdown is shown in Table 3.

Tangible Outcome:

1. Improvement of the treatment of wastewater discharged into the canal, as well as overall water quality of the canal. Various water quality parameters along the canal would be measured using quantitative indicators, before and after the project.
2. Increased community awareness of water use and wastewater disposal.

Division of Duties:

1. Korat will take the initiative in implementation of the project as the main implementing body.

2. ERTC will provide technical support (monitoring, water treatment technology, etc.); Submission of documents of past and ongoing activities of the project.
3. ESCAP will provide financial and overall guidance for the project.
4. IGES will provide coordination of the project; support and collaboration with technical experts and policy recommendations

## Table 1. Water quality of canal at inlet and outlet of the municipality

(on 6th May 1998)

| Parameter | Station 1 (Before flow into the City) | Station 2 (After flow into the City) |
|---|---|---|
| Time | 17.00 | 17.50 |
| Air Temp c$^{o}$ | 34 | 33 |
| Water Temp c$^{o}$ | 30 | 31 |
| PH | 7.57 | 8.31 |
| Ec | 395 | 735 |
| TDS (mg/l) | 246 | 434 |
| DO 0.5 m. | 5.8 | 8.8 |
| DO 1.0 m. | 8.8 | 8.2 |
| BOD | 4.6 | 33.3 |
| COD | 28.2 | 73.9 |
| Nitrate | 0.15 | 1.47 |
| Phosphate | <0.05 | 0.71 |
| Total Coliform (MPN/100 ml) | 700 | 160,000 |
| Fecal Coliform (MPN/100 ml) | 700 | 160,000 |

## Table 2. BOD simple water treatment plants

| Community | Date | Parameter | IN | OUT |
|---|---|---|---|---|
| Tung Sawang Salary | 10 August, 2001 | | | |
| | | PH | 5.9 | 5.9 |
| | | BOD | 188 | 66 |
| | 13 September, 2001 | | | |
| | | PH | 5.9 | 5.9 |
| | | BOD | 86* | 60 |
| Mahachai | 13 September, 2001 | | | |
| | | PH | 6.0 | 6.0 |
| | | BOD | 88* | 42 |

* High rainfall.

## Table 3. Cost breakdown

| Item | Details | Total Cost (US$) |
|---|---|---|
| Installation of wastewater plants for two communities (this may include one model plant with better technology) | Instant tank<br>Cover<br>Cement<br>Media<br>Labor | 4080* |
| Water quality monitoring and review | | 200** |
| Community Meetings | | 2500*** |
| Public awareness meetings | | 2500*** |
| Technical expertise, and coordination | | 5000**** |
| Communication and Reporting | | 920* |
| **Total** | | **15200** |

Notes:

| | | |
|---|---|---|
| * | To be provided by ESCAP | (as grant cash) |
| ** | To be provided by ERTC | (in kind) |
| *** | To be provided by Korat Municipality | (in kind) |
| **** | To be provided by IGES | (in kind) |

## Appendix from Ukita Sensei`s Report on Korat Project

Onsite Treatment in water channel in Japan

| Method | | Influent BOD (mg/l) | Influent SS (mg/l) | Removal efficiency BOD (%) | Removal efficiency SS (%) | Required Arca $m^2/(m^3/hr)$ | Initial cost $10^6$yen/$(m^3/hr)$ | O/M cost yen/$m^3$ |
|---|---|---|---|---|---|---|---|---|
| Sedimentation | Dam | ＜20 | ＜30 | 10～30 | 10～50 | 1 | 0.017 | |
| Filteration | Sand filteration | ＜20 | ＜50 | 30～60 | 60～95 | 0.03～0.28 | 0.5 | |
| Aeration | | | | ＜10 | ＜10 | | | |
| Contact Stabilization | Gravel or Plastics | ＜20 | ＜30 | 50～80 | 65～90 | 0.7～3.3 | 0.25～0.4 | 0.1～1.2 |
| Contact Stabilization | Chacoal | ＜20 | ＜30 | 50～70 | 70～85 | 0.8 | 0.17 | 0.6 |
| Biological | with aeration | 20～200 | 10～200 | 75～95 | 75～95 | 1.4～11 | 0.5～0.7 | 1.3～1.8 |
| Plant system | Water hyacinth | 10～100 | 10～100 | 30～50 | 30～40 | 470 | | |
| Ecosystem | Reed | 10～30 | 10～30 | 30～50 | 70～80 | 42 | 0.25 | 5.8 |
| Soil Treatment | | ＜10 | ＜10 | 80～95 | 90～95 | 5.6 | 0.72 | 1.6 |

Onsite Treatment for Water Channel in Chiba Pref.

| | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Flow rate designed | $m^3/D$ | 1600 | 1100 | 800 | 4000 | 500 |
| BOD designed | mg/l | 51 | 30 | 30 | 60 | 60 |
| Removal efficiency designed | % | 41 | 29 | 29 | 26 | 40 |
| With of without pump | | × | × | × | × | ○ |
| Attached Media | | gravel | resin mat | resin mat & ceramics | resin mat | plastic |
| Volume | $(m^3)$ | 36 | 13.2 | 20 | 70 | 68 |
| Depth | (m) | 0.2 | 0.05 | 0.15 | 0.15 | 0.5 |
| Capacity | (m/D) | 120 | 440 | | 250 | |
| | $(m^3/D)$ | | | 720 | | 500 |
| Residence Time | | 0.04 | 0.03 | 0.7h | 0.014 | 3.3 |
| | | ? | ? | | | |
| Cleaning frequency | (times/y | 2 | 2 | 4 | 7 | 2 |
| Sludge generation | | 1 | 3.2 | | 128 | |

| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| 500 | 500 | 2000 | 300 | 2000 | 500 | 750 |
| 40 | 50 | 97 | 50 | 50 | 50 | 80 |
| 60 | 60 | 45 | 40～50 | 30 | 60 | 75 |
| ○ | ○ | × | × | × | ○ | ○ |
| Bio-media ? | Bio-media | resin mat | plastic | resin mat | contact aeratri | 〃 |
| 103 | 130 | 40 | 52.5 | 40 | 20 | 277 |
| 2 | 2 | 0.2 | 0.5 | 0.1 | 5.1 | 17.5 |
| | | 400 | 150 | 200 | | |
| 500 | 500 | | | | 500 | 750 |
| 4.9h | 6.2h | 0.012 | 0.08 | 0.012 | 1 | 8.9 |
| | | | | | | |
| 2 | 2 | 6 | 6 | 12 | 4 | 1 |
| 2.8 | 0.7 | | 6 | 70 | 200 | 24 |

Removal Efficiemcy(%) and initial cost of onsite treatment in Chiba Prefecture

| | BOD | COD | SS (%) | TN | TP | Method | Initial cost $10^4$ yen |
|---|---|---|---|---|---|---|---|
| 1 | 40 | | | | | ○ | 7,067 |
| 2 | 67 | 32 | 33 | 40 | 21 | ○ | 8,641 |
| 3 | 25 | 12 | 72 | 19 | 27 | | 1,470 |
| 4 | 25 | 12 | 16 | 19 | | | 1,206 |
| 5 | | | 11 | | | | 895 |
| 6 | 11 | | | 31 | | | 188 |
| 7 | 33 | | 66 | | | | 74 |
| 8 | | | 11 | | | | 590 |
| 9 | 33 | | | 40 | | | 1,091 |
| 10 | | | 28 | 11 | 11 | | 1,043 |
| 11 | 36 | 23 | | 13 | 20 | ○ | 422 |
| 12 | 16 | 52 | 27 | | 48 | ○ | 2,098 |
| 13 | 50 | 28 | 29 | | 14 | ○ | 1,000 |
| 14 | | 30 | | | | ○ | 11,896 |
| 15 | 82 | 58 | | 13 | 56 | ○ | 6,880 |
| 16 | | | | | | | 2,100 |
| 17 | 20 | | 57 | 10 | | | 943 |
| 18 | 53 | 36 | 25 | | | ○ | 3,530 |
| 19 | 49 | | 60 | | | | 150 |

○: with pump

Relatively large plants

1yen=0.33B

Onsite Treatment for water channels in Chiba pref. In Jap

| | BOD loading ($kgm^{-3}d^{-1}$) | Flow velocity ($mh^{-1}$) | Residence time (h) |
|---|---|---|---|
| 1 | 2.3 | 211 | 0.5 |
| 2 | 2.5 | 100 | 0.3 |
| 3 | 1.2 | 144 | 0.6 |
| 4 | 3.4 | 206 | 0.4 |
| 5 ○ | 0.4 | 88 | 3.3 |
| 6 ○ | 0.2 | | 5 |
| 7 ○ | 0.2 | | 6 |
| 8 | 3.7 | 240 | 0.5 |
| 9 | 0.3 | 48 | 4.2 |
| 10 | 2.5 | 120 | 0.5 |
| 11 ○ | 1.3 | | 1 |
| 12 ○ | 0.2 | | 8.8 |
| 13 ○ | 0.2 | | 7.7 |
| 14 | 1.7 | 198 | 0.4 |
| 15 | 6 | 398 | 0.2 |
| 16 | 1.9 | 106 | 0.9 |
| 17 ○ | 0.2 | | 7 |
| 18 ○ | 0.2 | | 6 |
| 19 | 1.4 | 230 | 0.3 |
| 20 | 0.7 | 23 | 3.8 |
| 21 | 0.6 | 48 | 1.2 |
| 22 ○ | 0.2 | | 8.5 |
| 23 ○ | 2.2 | | 1.1 |
| 24 | 1.2 | 227 | 0.5 |

○: with pump