**Water pollution and control measures**

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LIANGNONG WATER POLLUTION & CONTROL MEASURES

I. Water situation in China

With her more than one billion people, almost one quarter of the world's total population, China is the most populous country, but her social and economic development is uneven due to the historical reason.

Comparing with U.S.A., China's population density is higher. There are more than twenty cities with population of more than one million in China, but in contrast there are only six cities with populations of more than one million in U.S.A. Urban population varies from about 6% in the remote provinces to more than 67% in others. The density of population varies from less than 2 persons per sq.km. (Tibet) to more than 1900 (Shanghai). Ninety percent of the total population living on only 17% of the land.

Concerning natural conditions, China is similar to U.S.A. on the geography and climate, annual precipitation ranges from more than 1600 mm in the southern coastal areas to about 600 mm in central area of the country to less than 200 mm in the northwest. China ranks among the lowest of nations in surface water resources per capita.

(see Table 1)

Among 0.8 billion rural population in China, only 0.3 billion have access to safe water supply, of which 15% is piped. The other 0.5 billion of rural population have problems with drinking water, including 45 million people who are supplied with water containing excess fluorides, 60 million who depend on brackish waters, 150 million who draw on polluted surface water that are not adequately treated and 50 million who do not have adequate source of water.

Due to the high density of the population, uneven economical development, deficient water source and population control, water borne infectious diseases such as dysentery and hepatitis which are common in developing countries are also common in China.

So the deficient water source has already obstructed the development of industry, agriculture, economics and resident's health, especially in some rapid developing metropolis like Shanghai, Beijing, Tianjin, Shenyang and Dalian.

II. General description of Liaoning Province

A. Population and economics. Liaoning is a coastal province in the northeast of China with a total population of 36.29 million persons living in an area of 145,700 sq.km, with a density of 249 persons per sq.km., it is amongst the most heavily urbanized provinces.

There are four super size cities with over one million people among the 22 in the whole nation. Liaoning's industrial base was developed in the early 20th century and proceeds much of China. It is the site of the well-known steel works in Anshan and coal mine in Fushun. Its foremost contribution is in heavy industry (output value RMB 457 billion in 1986) ranking it first among all provinces in heavy industrial output. It also ranks first in power generation, iron ore reserves and iron and steel production. Total industrial output was RMB 66,459 billion ranking it third in China after Jiangsu province and Shanghai metropolis.

B. Environment. Much of the urban environment in Liaoning province's highly industrialized cities is marked by severe pollution of air, earth and water. Epidemics of health-threatening levels of air pollution occur frequently; surface waters contaminated by industrial wastes pollute ground water which is used as a sources of drinking water, and crops irrigated with industrial wastewater because of water scarcity have become contaminated by toxics and rendered inedible.

C. Water environment. Liaoning province is situated between 39 and 43 deg. N latitude and between 119 and 126 deg. E longitude. It has a temperate continental monsoonal climate with a hot rainy summer; a long cold winter with little snow and a short windy spring. There are only 130-180 frostfree days. The average annual precipitation is 400-1000 mm decreasing markedly from southeast to northwest. There are 16 rivers with over 1000 sq.km. catchment among the total 221 rivers in Liaoning province. There are 19 reservoirs which have capacity over 0.1 billion cubic m. Although there are plenty of rivers and reservoirs, water resources are still deficient due to the uneven precipitation, high evaporation and the improper control measures. Annual water resources per capita is 987 cubic meters which is much lower than the national standard.

(See Table 3)

The table shows the worst center area with shortage of water supply and heavy pollution.

(See Table 4)

The Hunhe-Taizi river basin, running southwest through the heartland of Liaoning province is the focus of water resource concerns because of it's urban, industrial and agriculture pre-eminence in the province. It has located in or near it some of China's largest heavy industries and major sources of coal and iron ore and economically important cities of
Anshan, Benxi, Fushun, Liaoayang, Shenyang and Yingkou. The cities have a combined population of 9.7 million and account for about 58% of Liaoning's industrial output. However, the surface water can't meet the need of rapid development of urban water demand which had been increased 10 times since 1949 to 1985.

Most of liquid wastes generated in the province are discharged without treatment to the river system through industrial outlets, combined sewers or irrigation channels. So the polluted surface water even ground water can no longer be used.

D. Health impact. The greater part of these wastes containing the toxic and hazard pollutants as oil, phenol, cyanide, benzopyrene, entered the Hunhe and Taizi river basin, most of these wastes reappear in the supply of down stream users.

For example, over 700 sq.km. land and more than 30 drinking water wells are polluted by nitro-compound with concentration of 0.5 - 2.6 mg/l.

300 teenagers (polluted water drinkers over 10 years) were checked and heinz body in their blood were found, even higher than 12%, whereas the ratio was zero in another non-nitro-compound area (Shenyang).

The death rate of malignant tumour of the residents drinking the polluted water for longer period is 110.62 per 0.1 million, but only 72.26 per 0.1 million in areas with safe water, a 52% higher incidence rate.

The river water is heavily polluted by domestic wastes containing E-coli 4650/1; total bacterium 0.15 billion/l; chloride 500-1375 mg/l. The incidence of dysentery is 502.56/0.1 billion, typhoid fever, paratyphoid 2.57/0.1 billion, virus hepatitis 86.96/0.1 billion respectively among the residents drinking the polluted river water.

Shen-fu district farmland is irrigated by untreated waste waters from refinery plants which result oil content 328-410/100g soil and benzopyrene 226.5-500mg/100g soil. Oil content in water is 0.33-0.48mg/l, phenol 0.0042-0.05mg/l, benzopyrene (Bap) 0.025-0.08 ppb. Bap content in rice reaches 0.16-1.44ppb. The death rate of stomach cancer is 45/0.1 billion persons, but only 12/0.1 billion in another comparable but less contaminated district. Malformation foetus rate is 3.06/1000 and congenital malformation reaches 8.28/1000 which is 2-3 times higher than the other districts.

Fluoride content in some ground water is over 16mg/1 which poisons 0.53 million of residents, among them 0.396 million are suffering from yellow stains on the teeth and 3000 from bone fluorosis. The total patients of above mentioned diseases are 31,000.

III. Control measures

A. Co-financed urban study. With the Chinese government's approval, and Australian-funded Urban Renewal Study is being carried on in Liaoning Province at the present period.

On the water issue the study objects are as follows:

(a) To prepare a strategy for the development, allocation, use and management of the water resources of the central area of Liaoning Province (catchment of Hun-he and Taizi) and the treatment (industrial, municipal) of used water and its return to the environment. The strategy must seek to resolve existing or potential conflicts for water use (agriculture, domestic and industrial) and the attainment of an improved water quality environment.

(b) To decide on technically and financially feasible water quality goals (river, estuary and marine) to be attained step by step over a planned period of time.

(c) To propose (at strategy level) non-physical actions and financial investments for works that are required to best meet the competing interests of the water users and the disposal of liquid waste to the environment.

(d) To propose an action-oriented program for the orderly development of water resources and the return of used water to the environment. The program should address all major issues including:

(i) industrial waste discharge policy;
(ii) institutional reform;
(iii) regulatory, pricing and policy issues;
(iv) water resources development and allocation;
(v) program of physical works and non-physical action including measures to:
- improved efficiency of use by industry and agriculture
- pre-treatment of industrial waste as appropriate
- establishment of municipal waste water treatment works (including line treatment for agriculture re-use), and oxidation ponds
- development of augmentation of water resources and reuse of treated water for the augmentation of low season river flows and achievement of water quality goals.

(vi) to identify and evaluate significant projects (e.g. water supply, river control, flow augmentation or waste water treatment) that are essential to the overall strategy, so that they may proceed to independent feasibility studies, financial approval, funding and design construction decision prior to finalization of total strategy.

Additional reservoirs and possibly water transfer schemes, combined with improvements in the efficiency of water use and a reallocation among users, will be required to maintain adequate waste assimilation capacity of the river system. The basin, the water user and the waste producers would be viewed as parts of a common system, and plan construction and non-construction measures in a comprehensive integrated and basin wide way so water supply and water quality objectives can be achieved at least cost.

B. Regulations and Laws. The Environmental Protection Bureau of Liaoning Province (EPB) has prime responsibility for controlling liquid wastes to rivers and irrigation areas. National standards for licensing discharges were issued in 1973 and new national laws were promulgated in 1983. Essentially the system acts as a pollution "tax" and industries have the option of investing in treatment facilities or paying the tax.
At the national level the following policy measures are emerging to promote conservation and reduce pollution:

(a) Increase the water resources tax payable by industry.
(b) Impose quotas on industrial consumption based on production and technology type, and tax quota exceedance.
(c) Regulate to force water reuse.
(d) Strengthen "pollutions pays" policy measures.
(e) Devote more attention to non-point pollutant sources.
(f) Employ rational policy for promoting treatment: require pretreatment for selected pollutants but in general require municipalities to build regional treatment facilities.
(g) Finance for capital works will come from national or provincial governments but municipalities will pay for operation and maintenance.
(h) Sewer department will be self-financing and will apply tariffs accordingly.

C. The way ahead. We have focussed on Liaoning's growth prospects and the concomitant need for water supply and drainage. Liaoning's industry will be a key element in China's modernization and export drive. Economic and urban population growth is expected to exceed the national average and will occur in the central area of the province. We will have to catch up in the provision of urban service, especially water supply. Recognising the need of sizable investments the National Government has agreed to more equitable cost sharing arrangements than in the past. Liaoning and its municipalities will better mobilize financial resource through taxation, borrowing and increased reliance on user fees.

Map of Administrative Districts of Liaoning Province in China
### TABLE 3
WATER RESOURCE DISTRIBUTION IN LIAONING

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<th>EAST</th>
<th>SOUTH</th>
<th>WEST</th>
<th>CENTER</th>
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<tr>
<td>GROUND WATER</td>
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<td>0.371</td>
<td>1.490</td>
<td>5.454</td>
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<tr>
<td></td>
<td>2%</td>
<td>4.97%</td>
<td>19.96%</td>
<td>73.07%</td>
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<tr>
<td>SURFACE WATER</td>
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<td>5.835</td>
<td>4.467</td>
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<td>17.41</td>
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<td>33.43</td>
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### TABLE 4
URBAN INDUSTRY/DOMESTIC WATER CONSUMPTION IN LIAONING

<table>
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