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Human Health Aspects of the Impact of
The Urbanization of Seoul, Republic of Korea

Report of a Study for the Smithsonian
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William A. Hall, M.D.
Center for Environmental Studies
Princeton University

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SUMMARY

A two-week investigation of the impacts on human health, related to environmental changes, following rapid urbanization of Seoul, Korea, was carried out under the auspices of the Smithsonian Institution.

The principle threats to health developing out of urbanization, were found to be accidental injury and tuberculosis. Accidents are due to industry and automobiles, while tuberculosis increases with crowding and unsanitary conditions. Increasing deaths due to heart disease are probably attributable to urban stress, exacerbated by chronic and acute carbonmonoxide poisoning. A marked increase in respiratory illness is related to worsening levels of air pollution.

Enteric disease is an important cause of loss of human productivity in Seoul. Crowding, use of night soil on crops, lack of waste water and sewage disposal systems, inadequate water supply, and generally unsanitary conditions, combine to create a situation where 80% of Seoul residents harbor some form of intestinal parasite. 1% of city residents carry typhoid and about 0.7% harbor shigella. The national dish Kimchi is one of the principle vehicles for spread of intestinal parasites.

Air pollution levels in the city are increasing and are already far in excess of levels considered dangerous in the United States. Industry and Coal home heating

account for SO₂ and CO, while automotive vehicles yield most of the NO₂ and add a significant increment to CO. The increasing incidence of respiratory infections, chronic non-infectious pulmonary disease, and probably an increasing morbidty due to ischemic disease of the cerebrovascular system and heart, are probably closely related to the worsening air pollution. The writer found evidence suggesting that chronic low level carbonmonoxide poisoning is an important and virtually overlooked health problem in Seoul.

Water pollution is a serious problem in Seoul. No waste water disposal or sewage treatment system is in operation. The water distribution system is inadequate, and probably still suffers periods of negative pressure in some areas. Many slum dwellers rely on shallow wells, almost 100% of which are seriously contaminated. Failure to treat hospital wastes threatens to compound the problems of transmission and treatment of infectious disease. Raw sewage is often used to fertilize crops. Night soil collection and treatment systems are grossly inadequate. Little is known about water pollution by industrial wastes at this time.

Syphilis and probably other venereal diseases are gradually spreading through the city population, a usual phenomenon accompanying urbanization. Incomplete data indicate an increase in emotional illness but probably not out of proportion to the population increase. Alcoholism,

indigency, rape and homicide appear to be increasing more rapidly than the population.

The quality of the Korean environment has been diminished by decades of destructive war. The division of the nation into North and South Korea separated the principle mineral and water resources of the North from the traditionally agrarian economy of the South. Industrialization and forced draft urbanization are not only rapidly degrading the internal environment of the city, but much of the countryside is being redesigned to support the industrial movement. Thus river basins are rearranged, irrigation and canal systems created and marine shore lines are extended. Losses in aesthetic values, gradual disappearance of amenity living and accelerating change in culture and traditions, may well threaten precious and fragile concepts and values which have permitted the people to endure generations of travail.

Proposed approaches toward solution of existing problems in Seoul, which it is hoped will have some relevance for cities in other developing nations, are as follows.

1. Development of monitoring systems for all resources, renewable and non-renewable.
2. Development of a readily accessible data base, which reflects all parameters necessary for a full understanding of the environmental situation.
3. Improved communications between federal and local authorities, industry, research and development

institutes such as RIST, I.I.S., and active participation of the university sector. A rearrangement of federal agencies such as resulted in the US, EPA should be considered.

4. Improved manpower training and research programs in the area of environmental studies.
5. Street and road improvement programs, along with improved mass transport systems and exclusion of private vehicles from highly congested and polluted areas. Vigorous enforcement of traffic laws.
6. Gradual development of a water carriage sewage system, and systems to allow safe use of night soil, appear to be the best intermediate strategies for handling human waste.
7. Improvement of the water distribution system and a careful analysis of the possibility of supplying the city's water treatment plants by aqueduct.
8. Careful planning for land use including development of legislation encouraging location of industry in areas where they are least likely to do harm. Creation of open space by relocation of substandard dwellings, and close-in farming, should be encouraged by legislation.
9. The tuberculosis detection and treatment program needs strengthening. Provision of these services without charge would encourage their use and is in the best interest of the city and nation.

10. Alternatives to Ondol heating, and/or measures to prevent CO leakage, especially in cities, must be found.
11. Industrial health and safety, public health and sanitation, and building construction for fire and safety, should be submitted to careful analysis, corrective legislation and vigorous enforcement.
12. Means must be found to discourage the uncontrolled immigration from the rural areas. Careful attention to redressing economic and social infrastructure deficiencies in order to improve the farmers' lot are necessary.
13. Improved distribution of health care is an important aspect of social infrastructure development. Consideration should be given to creating an intermediate level of medical practitioner.
14. Overall dampening of population growth is a continuing necessity, but is a consideration beyond the scope of this report.

HUMAN HEALTH IMPACTS OF URBANIZATION
IN SEOUL, KOREA

(Report of Study for the Smithsonian
Institution, March, 1972)

INTRODUCTION

The exact population of Seoul is unknown but increasing rapidly, reaching approximately six million in 1971. The national decision to push industrialization is largely responsible for urban migration, since industrialization requires cities as centers for communication, banking and entrepreneur type activities, labor pools (especially for labor intensive industry), transportation, etc. The population of Seoul is increasing about 10% per annum, and the city now contains 18% of the nation's population. The national rate of population increase is 2%.

South Korea is one of the most densely populated countries in the world and the average annual income is about \$200. Concentration on industry has resulted in relative neglect of agricultural areas and the nation does not produce its own food requirement. The rural population is both pulled toward the city in hope of increased standard of living, and pushed out of the countryside by the neglect of the government to invest substantially in the social infrastructure of the rural environment. Only 20% of South Korea is arable and considerable amounts of land close into the cities are being taken out of agriculture and used for urban living, commercial and industrial space.

MORBIDITY PATTERNS AND LIFE EXPECTANCY IN KOREA

The data base is extremely poor but improving gradually. It must be emphasized that, on the average, only 49% of deaths in Korea are reported at all. Of all deaths reported in the special City of Seoul, 78% are reported by doctors, 5.8% by herb doctors and 15.5% by laymen. In rural areas as high as 93.1% of deaths are reported by laymen. For the country as a whole only 28.2% of reported deaths are by doctors.

Bearing the poor data base in mind, it appears that the crude death rate in the country is improving slowly, e.g. from 14.3 per thousand in 1951-55 to 11.89 per thousand in 1967. The proportion of deaths due to senility is increasing slowly (26% in 1958 to 32.6% in 1967), reflecting an increasing life expectancy in the country. From 1958 to 1966 there has been a striking decrease in infant (age less than one year) mortality. In 1938 about 200 out of each 1,000 children under age one year expired, while in 1966 this figure had fallen to about 29 out of 1,000.

The reduction in neonatal mortality is the most important contribution to increased life expectancy. This trend roughly parallels the world-wide reduction in infant mortality during this time period. Nevertheless in 1970 the average life expectancy in South Korea was only 66 years, compared with 70 years in the United States and 73 years in Japan (Ref.1).

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In the ten-year period between 1958 and 1969 there has been no change in the two leading causes of death nationally, respiratory disease including pneumonia and tuberculosis ranking 1st and 2nd respectively. In recent years diseases affecting the central nervous system and cancer have risen to 3rd and 4th place. As in most Asian countries, heart disease ranks low among the leading causes of death. However, accidental death has increased in frequency as might be expected in an urbanizing and industrializing nation.

It is especially interesting that the national death rate due to tuberculosis decreased only slightly from 1958 to 1970, and most of the decrease was seen in children under fifteen. While facilities for detecting tuberculosis have improved slowly, the pharmacologic treatment of tuberculosis has improved dramatically. Nevertheless the most important factor in the improvement of the tuberculosis picture is the official practice of immunizing all known children under five years of age with BCG vaccine. (Ref. 2)

A survey of 65,000 Koreans living in Japan made in 1960 revealed that tuberculosis did not rank among the ten major causes of death, while during the same time period tuberculosis ranked 3rd among the leading causes of death in Korea. More will be said later in this report concerning the tuberculosis problem. While reporting is incomplete, one study (Ref. 3) shows that the death rate due to tuberculosis increased in Seoul from 9.7% in 1966 to 9.9% in 1967. Of greater importance is the increase in deaths by accident from 9.5% in 1966 to 14.7% in 1967.

Table No. 1 (Ref. 4 and 4a) shows the leading causes of death in Seoul in 1966, 1967 and 1968. (The latest studies the writer could obtain.)

TABLE No. 1
Ten Major Causes of Death in Seoul

1966		1967		1968 (Ref.4a)	
Cause	%	Cause	%	Cause	%
Diseases of central nervous system	13.4	Accidents (including motor vehicle)	14.7	Accidents (including motor vehicle)	15.
Tuberculosis* (respiratory)	9.7	Diseases of the central nervous system	10.4	Diseases of central nervous system	10.
Accidents (including motor vehicle)	9.5	Tuberculosis* (respiratory)	9.9	Tuberculosis* (respiratory)	10.
Hypertension	7.3	Senility	8.0	Gastritis, etc.	8.
Neoplasms	6.3	Gastritis, duodenitis, enteritis and colitis	7.9	Senility	8.
Senility	5.6	Heart Diseases	7.5	Heart disease	7.
Pneumonia	4.8	Neoplasms	7.2	Neoplasms	7.
Asthma	3.8	Infant diseases	5.1		
Gastroenteritis	3.4	Pneumonia	4.5		
Hepatitis	3.3	Kidney diseases	3.6		

* Note Tuberculosis of all forms = 15%

It is clear that death due to accidents (which are probably mainly related to increased industrialization and automobile traffic) increased significantly. Tuberculosis increased slightly and gastroenteritis increased dramatically, probably reflecting increased crowding. Heart disease appears on the 1967 list for the first time.

In Kwon's 1968 study of principle causes of death in Seoul it emerges that death due to tuberculosis of all kinds are exactly equal to accidents (including motor vehicle accidents) as causes of death. Plainly, a person living in Seoul runs a great risk of having his life cut short by accident or tuberculosis. It must be born in mind, however, that even in Seoul, the most modern of Korean cities, only 78.7% of all deaths are reported by physicians.

A very interesting difference in mortality pattern between urban areas and rural areas can be seen in Table No. 2.

TABLE No. 2

Rank Order of Ten Major Causes of Death in Urban and Rural Areas in Korea (abridged)

Rank	Urban Areas 1966-1967	Rural Areas 1956-1960
1	Vascular lesions of the central nervous system	Vascular lesions of the central nervous system
2	All other accidents	Gastroenteritis (unspecified age groups)
3	Senility	Senility
4	Tuberculosis (pulmonary)	Tuberculosis (pulmonary)
5	Neoplasms	Heart disease
6	Gastroenteritis (excluding newborn)	Pneumonia
7	Motor vehicle accidents	Prematurity
8	Pneumonia	Tetanus
9	Heart disease	Accidents (cause unspecified)
	Kidney disease	Cancer

While the years of reporting and terminology differ slightly, it is evident that the principle risk to life of moving into an industrialized, urbanized setting, is death by accident.

CROWDING AND TRANSMISSION OF AIRBORN COMMUNICABLE DISEASE

Increased density of population results in a higher risk of contraction of airborne communicable diseases. This is because the transmission distance is reduced, leading to increased chance that disease-bearing particles will survive long enough to infect others, and encounters with infected persons are more frequent. Seoul, a city of approximately 613 square kilometers and bearing approximately six million people, is one of the most densely populated cities in the world.

A. Tuberculosis

Among the serious airborne communicable diseases, tuberculosis is, par excellence, illustrative of the importance of crowding. The Ministry of Health and Social Welfare reports a total overall increase in tuberculosis in the nation, among non-B2G vaccinated persons from 59.7% in 1965, to 64.8% in 1970. On the other hand the reduced incidence in children under 15 years of age is shown in the following table.

TABLE No. 5

	0 - 4	5 - 9	10 - 14
1965	10.2%	55.7%	69.5%
1970	8.5%	26.1%	59.1%

This important decline reflects the benefits of the program instituted in 1962 under the combined auspices of the Ministry of Health and Social Welfare and the World Health Organization, of BCG vaccination in all children under age five years. Nevertheless, the tuberculosis rate increased in the principle urban areas. The 1971 Statistical Year-book of Seoul shows admissions to hospital for tuberculosis numbered 212,000 in 1966, and 234,000 in 1970. This increase is small in proportion to the population increase, and suggests that a decreasing percentage of the urban population is actively seeking treatment for tuberculosis.

B. Other Airborn Diseases

While no firm data is available, the writer was assured by several public health specialists that the incidence of upper and lower viral respiratory infections, and upper and lower bacterial respiratory infections is increasing in Seoul City and that the incidence has been higher than that in rural areas for many years. No data is available on viral exanthems, pertussis, diphtheria, bacterial meningitis, etc.

C. Ondol Heating and Tuberculosis

Since prehistoric times the Korean peoples have used a unique heating system in their homes. This consists of a small stove located in the floor of the kitchen. The draft intake leads to the bottom of the stove and may be adjusted. Hot air and gasses exiting from a flue at the side of the stove (just above the combustion chamber level),

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are distributed under the floor of the living rooms and finally up a stack on the side of the home. Fuel in the countryside is usually wood, but in urban areas is usually a large, formed and fluted, briquette, consisting of powdered anthracite coal mixed with clay. The vast majority of homes in Seoul use this floor heating system, and it is used in modern low-rise housing developments, to heat the individual dwelling unit. Dwelling units in the city are more tightly constructed than in the countryside, and are of course more crowded. Very probably, this heating system contributes to the spread of tuberculosis in families since adequate heating is obtained only by reduced ventilation in the home. It has been adequately demonstrated that the tubercle bacilli is transmitted through the air and can survive suspended in warm air for more than an hour (Ref.5). It is of particular interest that tuberculosis is slightly less prevalent in the countryside where crowding is less severe and poorly constructed homes provide better ventilation.

D. Airborn Enteric Diseases

While no data is available it should be born in mind that crowding may contribute to the transmission of infectious hepatitis and intestinal parasitosis. Ascaris eggs and Enterobius eggs can be inhaled, leading to infection. No data is available on infectious hepatitis.

CROWDING AND TRANSMISSION OF WATERBORNE
AND FOOD BORNE DISEASES

Enteric Infections

As is the case in airborne diseases, the reduction of transmission distance and the increased number of encounters, are important aspects of crowding in water and food borne diseases. In a recent study, approximately 1% of apparently healthy persons in Seoul were found to be typhoid carriers, and approximately .7% were shigella carriers. (Ref.6) In another recent study a very high prevalence of intestinal parasites were found in Korea (Ref.7). Prevalence rates are shown in Table No. 4.

TABLE No. 4

		1970 Average of All Areas %	1970 Seoul %	1949 Seoul %
	Positive for one or more Helminths	75.1	75.9	95.2
HELMINTHS	Ascaris	46.0	34.0	81.4
	Trichuris	46.8	65.0	86.8
	Hookworm	6.8	3.4	38.4
	Trichostrongylus	7.0	5.9	35.3
	Clonorchis sinensis	12.1	2.5	5.4
	Enterobius Vermicularis	1.6	2.0	--
	Hymenolepis nana	0.7	0.5	--
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PROTOZOANS	Entamoeba Histolytica	6.4	4.8	4.8
	Entamoeba Coli	20.5	16.3	26.4
	Giardia Lamblia	5.1	3.8	3.8
	Endolimax Nana	10.0	5.4	8.4

Staggering as the 1970 infection rate may be, comparison with the 1949 rate shows a considerable improvement, most importantly in hookworm infestations. This has not been paralleled by improvement in *E. histolytica* infections. One may conclude that food borne infections have declined, but the continuing high incidence of *E. histolytica* indicates probable water contamination with sewage and the general resistance of this disease to therapy.

In summary, the overall population of Korea currently shows infection with one or more intestinal helminths or protozoans at a rate of 80%. It is interesting that the helminth least likely to be distributed by airborne eggs (*Trichuris*) is that which makes intestinal parasitism more common in Seoul than in the country generally. Fortunately, *Trichuris* is one of the less severe forms of intestinal parasitosis, but can nevertheless contribute to anemia.

Small outbreaks of typhoid, shigella dysentery and cholera have been reported from Seoul and will be discussed under the heading of water pollution.

MARKETS, RESTAURANTS AND REFRIGERATION

Although municipal statutes bearing on sanitation in restaurants, markets, refrigeration requirements, etc., exist, these do not seem to be rigorously enforced. Vendors hawking unrefrigerated meat and raw fish were observed in several markets visited. Boxes of vegetables and fish can be seen resting in curbside gutters, bathed by gutter fluids. Restaurant inspections are said to be frequent, but closures

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due to improper sanitation are infrequent. Refrigeration in the home is an uncommon luxury in Seoul, and housewives do their daily marketing under conditions described above. It has been well established that typhoid, cholera, bacillary dysentery, infectious hepatitis, most intestinal parasites, trichinosis and several forms of viral and staphylococcal enteritites are readily transmitted under conditions such as these. When it is recalled that many fish, oysters, and vegetables are eaten raw, the prevalence of enteric infections (both acute and chronic) in Seoul can readily be understood.

AIR POLLUTION

Principle Sources

The major sources of air pollution in Seoul are

1. Ondol Home Heating
2. Motor Vehicles
3. Industry

Studies done by the Ministry of Public Health and Social Welfare (Ref.8) show increases in average Seoul ambient air levels of SO₂ from .0058 ppm in 1965 to .092 in 1970. Thus current SO₂ levels are already twice as high as averages (.04 ppm) in the United States, above which impairment to human health has been observed. Moreover a 1969 study by Chung, K.C. et al (Ref.9) disclosed central city street level maximums as high as 0.44 ppm in the daytime. When the known synergistic effect between SO₂ and dust particles is viewed in the light of the extremely heavy dust fall in Seoul (vide infra) one can only conclude that a dangerous situation exists.

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A 1971 report (Ref.10) shows a four-year evolution of NO₂ levels in Seoul as seen in Table No. 5.

TABLE No. 5

Concentrations of NO₂ by the Area in Seoul
24 Hour Averages (units in ppm)

Year	Industrial Area	Semi-Industrial Area	Commercial Area	Residential Area	Park Area
1965	.085	0.045	0.058	0.029	0.024
1967	0.160	0.218	0.164	0.089	0.079
1968	0.260	0.198	0.129	0.100	0.082
1969	0.454	0.238	0.157	--	--

Ranges for commercial areas over twenty-four hour periods in 1969 are from as low as 0.075 ppm between 4:00AM and 6:00AM to as high as 0.540 ppm between 8:00AM and 10:00AM when auto traffic is greatest (24 hour mean 0.296). Similarly in industrial areas the range is from a 4:00-6:00AM low of 0.120 ppm to an 8:00-10:00AM high of 0.640ppm (24 hour mean 0.357ppm).

United States (Air Quality Criteria for Nitrogen, Oxides, EPA, 1971) indicate that adverse health effects, such as increased susceptibility to respiratory infections, and impaired ventilatory function, are seen when the mean twenty-four hour NO₂ concentrations are at levels as low as 0.062 ppm.

While explicit comparisons cannot be made, since the time periods averaged are not clear from the Korean reports, it is quite evident from the data that the health of Seoul citizens is already threatened. Residential levels of NO₂ and levels in industrial and semi-industrial areas are well

above the dangerous level. Even the parks have unhealthy air by United States standards.

A recent study (Ref.11) showed total dust fall levels as high as 95.44 tons per Km^2 per month in the downtown Seoul area in 1970.

Unfortunately there is no hard data on human health problems related to these extremely high levels of air pollution. However, many physicians contacted assured the writer that a very large increase in patients with acute upper and lower respiratory infections, chronic bronchitis and bronchiectasis has been seen in Seoul hospitals, in recent years.

Daily ambient air averages for CO run about 33.37 ppm, but are up to three times as high in the downtown area. The number of cases of acute and chronic cases of carbon monoxide poisoning in Seoul increases annually. Ondol heating appears to be an important factor in this threat to health, due to incomplete combustion of fuel resulting in high carbonmonoxide generation. Kwon's study (Ref.13) revealed hazardous conditions (room levels of CO above 100 ppm) in 62% of all living rooms and 72% of all kitchens tested. Slum houses were higher in CO than "ordinary" houses, farming area houses showed the lowest CO levels generally, even though 30% of living rooms and 48% of kitchens showed unsafe levels.

Sohn's study (Ref.12) shows increasing morbidity from CO poisoning from 1944 through 1966. The highest CO levels were found in homes of the very poor, and of the wealthy. Sohn concludes that incomplete combustion of fuel in poorly constructed furnaces accounts for the first case, while

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inadequate ventilation as a result of improved construction of houses, accounts for the second. Exposure to 10 ppm of carbon monoxide for about eight hours tends to dull mental performance and the United States EPA considers CO levels above 10 ppm unsafe. One can hardly avoid the speculation, that the high morbidity and mortality rates in automotive accidents in Seoul, may be related to excessive home carbonmonoxide levels, high ambient and very high street level concentrations of carbon monoxide. The increasing industrial accident rate may also be related. Dulling of mental performance may be compounded by visual impairment. Beard & Wertheim* at Stanford have found reduction of visual acuity of up to 17 1/2% after only one hour's exposure to 50ppm of CO.

Interesting also is the increase in deaths due to cerebrovascular accidents seen in Seoul hospitals. It is quite possible that some deaths due to cerebral ischemia may be precipitated by the diminished oxygen-carrying capacity of blood heavily loaded with carboxyhemoglobin. It is the writer's understanding that death due to heart disease appeared on the Seoul list of ten most common causes of death, for the first time in 1967. Here again one can hardly avoid the conclusion that diminished blood oxygen-carrying capacity may be a strong contributing factor to morbidity and mortality due to heart disease in the city. There is abundant evidence in the United States that ischemic heart disease is exacerbated during episodes of heavy air pollution.

* Unpublished data.

With respect to human productivity and general well-being, it must be concluded that air pollution, particularly carbon-monoxide pollution has reached a very serious level in Seoul. Motor vehicles and Ondol home heating appear to be the principle contributing factors in carbonmonoxide pollution. Ambient room air levels considered dangerous by Korean public health authorities (100ppm) appear to be set far higher than are consistent with unimpaired mental performance and visual acuity.

The writer was unable to find sufficient data on other important air pollutants such as PAN, hydrocarbons, lead, nickel, cadmium, etc. from which to draw conclusions.

WATER POLLUTION

Prevalence of Enteric Disease

The overall picture of intestinal helminth and protozoan infection in Seoul is discussed on page 9 of this report. Data extracted from the 1971 Statistical Yearbook of Seoul (Table No. 6) shows the incidence of typhoid and cholera in Seoul from 1965 onward.

TABLE No. 6

YEAR	Typhoid		Cholera	
	Cases	Deaths	Cases	Deaths
1965	840	28		
1966	303	18		
1967	405	19		
1968	265	2		
1969	864	15	43	1
1970	1154	19	68	1

Several physicians (who preferred to remain anonymous) told the writer that the incidence of cholera in 1970 and 1971 was considerably higher but that reports had been suppressed due to fear that public reports of real incidences would have an adverse effect on tourism. The incidence of typhoid, however, clearly reveals that the city has made little progress toward solution of the problem.

Sewage Collection and Treatment System

Water carriage sewage collection is installed in only large office buildings, hotels and elegant homes in Seoul, and there is no sewage treatment system whatever. A large sewage treatment plant is under construction in Seoul, but it is estimated that it will handle only a small fraction of Seoul's total output of waste water.

The repository for human excrement in Seoul is the privy. In the central city area, much of the sewage drains into a large covered channel (the Chungyecheon) which was, at one time, a river. The Chungyecheon drains into the Han River. Approximately 16 other large drains empty raw sewage into the Han as it flows by the city. Progressing outward from the center of the city one finds many privies emptying directly into small streams which eventually drain into the Han, and an increasing number of dug privies. This type of privy must be emptied manually. Further analysis of the privy will be given later in this report.

Water Supply and Distribution

All water for piped distribution is treated. Several large treatment plants are in operation. Piped water is reported to be supplied to 86.8% of Seoul residents. It is widely known among public health physicians that many shallow dug wells are still in use in the slum areas, and some old dug wells remaining in central Seoul have been used during times of water shortage. Kwon in his investigation of slum area wells (Ref.13) found that 67% of wells inspected were located close to and below latrines. Many wells revealed heavy coliform counts and were so shallow as to be washed out during heavy rains.

Of all water pumped from water treatment plants, approximately 40% is unaccounted for. Old piping, faulty connections, and cracking of piping, where it is laid above the frost line, probably account for much of the loss. While public officials deny back pressure due to inadequate water supply for several years, many private citizens speak of frequent loss of pressure at the tap. Wherever and whenever back pressure does occur a serious hazard is created, since leaking privies are often located close to water connections.

The Privy, Night Soil and Water Pollution

In homes visited, the privy was often located within a few feet of the water tap. In such circumstances cross contamination can easily take place, especially during the wet season. During heavy rains privies often wash out altogether. Observation of night soil collection from homes, revealed the

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constant danger of cross contamination from slop over of hand carried night soil buckets, in the home, along the narrow alleys and streets and even in areas where many families use a community water tap. When the incidence of asymptomatic typhoid carriers is 1% of the general population, the problem of night soil collection and cross contamination cannot be considered trivial.

Night soil collection and delivery routes run along public thoroughfares, and leakage from several trucks was observed. The tracking of night soil from streets into homes is an ever present danger, especially during the warm and rainy summer. Night soil collected in trucks is, for the most part, delivered to huge collection basins where it is allowed to digest and concentrate by evaporation and ground filtration. The concentrated product is then bagged and sold. One difficulty is that parasite eggs can survive for up to nine months under cold conditions. The collection basins often overflow during the rainy season and in some cases the overflow goes directly into tributaries of the Han River. Squatter housing is often located nearby the collection basins. The writer observed water being pumped from a dug well, less than fifty feet from one of these basins.

As mentioned previously only about 25% of human excrement is collected and pooled for digestion. Many privies empty directly into small streams and many "close in" farmers use untreated night soil as fertilizer.

In the opinion of a number of Social experts in Public Health, the use of night soil is the greatest single hazard to public health in the city.

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Industrial Water Pollution

Approximately 4000 factories are located in Seoul City and 1800 small factories are located in residential areas. The main water pollutants from these factories are thought to be sulfuric acid, mercury and wastes from food processing. A few zinc mines are still in operation. Since zinc and cadmium are often found together it seems likely that mine drainage may pollute the Han River with some amount of cadmium. Facilities are not available at this time for sophisticated monitoring of heavy metal and other industrial pollutants, which might constitute health hazards.

Agricultural Run-Off Pollution

A great deal of "close-in" farming is carried out, even within the Seoul City limits. Much run-off takes place from these farms as well as from river basin farms throughout the several drainage areas. Fertilizer run-off, either in the form of night soil or processed fertilizer, presents a continuing hazard to human health. Heavy fertilization with nitrates with subsequent degradation to nitrites, constitutes an important child health hazard in farming areas, especially when shallow wells are used for drinking water. Insecticides are used in great quantities in South Korea and while chlorinated hydrocarbons have yet to be established as hazardous to human health, mercurials, and arsenicals are definite health hazards when passed up the food chain. Several local outbreaks of malathion poisoning have occurred in farming areas and while not a general health hazard, insecticides of this type should not be ignored.

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Hospital Sewage Pollution

Since no sewage treatment is in operation, all hospital wastes go more or less directly into the Han River. Recent experience in the United States and elsewhere has shown that antibiotic resistant organisms are common in city sewage, and that the resistance factor can be transmitted to previously sensitive strains of bacteria. During warm and high water periods it is not difficult to predict pollution of shallow wells with E. Coli, V. Cholerae, Shigella and other bacteria which have acquired immunity to one or more antibiotics. A potentially serious hazard to human health exists whenever hospital wastes go untreated.

Other Health Aspects of River Pollution

Current plans call for extensive development of several river basins in order to provide flood control, low-flow augmentation, irrigation and hydroelectric power. The distribution of the snail vectors of Liver Fluke, and Lung Fluke disease may be influenced by changes in water flow and distribution. Since the Korean people are avid consumers of raw fish and snails, this potential health problem should be carefully investigated.

Pollution of the Han River estuary and other river estuaries has already resulted in deterioration of the fishing industry. Many oyster beds have been condemned and fisheries along the coast have turned up as high as 13% fish and 33% cuttlefish contaminated with *Vibrio Cholerae*.

Recreation

Simply stated, most of the Han River, accessible to the Seoul public, is so badly contaminated now as to be unsafe for swimming, and unattractive for general recreation purposes. Yet the river banks constitute (for practical purposes) the principle accessible outdoor recreation areas. Stabilization of water flow throughout the year, as is proposed for the Han near the city, is not likely to improve the river's potential recreation value. Such a strategy is more likely to result in increased pollution, unless it is accompanied by meticulous sewage treatment. In view of the multiple sewage outfalls along the river banks of the city, treatment sufficient to allow intensive use of the Han for recreation, is a distant prospect.

In Seoul the acreage under cultivation, and forested land is decreasing, as space is made available for factories, roads, dwelling units and commercial enterprise. Such usage of land can be viewed as a form of soil pollution.

Night Soil

The use of untreated night soil on farm land is perhaps the most ancient form of soil pollution in the world. While the effectiveness of night soil as a soil replenisher cannot be gainsaid, the importance of night soil in the transmission of enteric disease, outweighs any other consideration. The question of whether or not night soil can be used safely hinges on whether or not it can be rendered harmless by treatment. Only a small portion of night soil used in Seoul and vicinity

receives any treatment whatever. Most of the night soil is poured into the fields and paddies in its raw form. Even that night soil held in basins has been shown to harbor viable Ascaris eggs for up to nine months, the cold season being the least effective holding period since the helminth eggs are preserved more effectively.

While plans are underway to develop night soil treatment facilities in the next few years, it is problematic as to whether a sufficiently economical method can be developed. In any case, most night soil bypasses current treatment facilities, and it would seem predictable that, unless and until, a universal sewage collection facility is developed, this situation will continue.

The distribution of disease as a function of the use of night soil has been discussed earlier in this report.

Manufactured Fertilizer and Insecticides

As increasingly intensive agriculture is practiced, plans call for more and more extensive use of manufactured fertilizer and insecticides. (Ref.15) While the predicted increase of rice amounts to only about 20%, the predicted increase in fertilizer amounts to 50%, and that of insecticides 200%.

Much of this increase in fertilizer and insecticide use will take place in the developing four major river basins flowing into the Man. Thus the city water supply will be polluted by an increasing amount of phosphates, nitrates, organomercurials, organochlorides and arsenicals. Biological

amplification of pesticides and fungicides presents the possibility of increasing hazard to human health. Heavy eutrophication of dammed waters is predictable. With respect to nitrate fertilizer, its transformation in the soil and appearance in shallow wells in the form of nitrites is predictable, and increasing illness due to methemoglobinemia will undoubtedly be seen.

No figures are available on what percentage of insecticide increase, will be in the more rapidly degradable types.

Contamination of Food

Contamination of vegetables and marine produce due to night soil use is discussed elsewhere in this report.

In the writer's search of available literature, no mention of pork and trichinosis was found. Separation of garbage and offal from other trash as practiced in Seoul, suggests that this material is fed to swine. The importance of insuring cooking of such swine food sufficiently to destroy the larvae of *Trichinella Spiralis* cannot be overemphasized. As urbanization and population density increase, the possibilities of transmission of this presently incurable disease are intensified.

Home refrigeration is unavailable to the vast majority of families in Seoul and according to physicians consulted outbreaks of salmonellosis and staphylococcal food poisoning are very common. It is predictable that these illnesses will increase in frequency as an increasing number of housewives are forced to shop daily in marketplaces where sanitary

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conditions are by western standards, appalling. Where unrefrigerated meat is displayed for hours on end, unrefrigerated fish and vegetables are displayed in porous containers resting in the gutter, and where only the most desultory cleanup procedures are practiced, the public food market becomes a major focus for the transmission of enteric disease.

Inspections of restaurants and food processing plants are being carried out presently in Seoul. Increasingly strict regulations are planned, since many unsanitary eating places have been found and a large amount of processed food is condemned annually. One can only hope that the promised stricter enforcement of sanitary codes will be forthcoming, but the difficulties of carrying out such programs will be enormous in a city undergoing an annual population increase of 10%.

No discussion of food sanitation in Korea would be complete without comment on Kimchi. This preparation of pickled and partially fermented vegetables is eaten by virtually all Koreans, past weaning age, at least once each day. This dish is undoubtedly responsible for much of the prevalence of intestinal parasitism in the population of Korea. *Ascaris* eggs remain viable for many months in this preserve. Various methods for eliminating viable eggs have been tested, but no economical and safe method has been found. The contamination of vegetables by night soil and in the market place is responsible for the prevalence of this food as a vehicle for the transmission of intestinal parasites. The magnitude of this problem in Seoul is increased by the forced draft food production methods necessary to nourish the dense city population.

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ANEMIA AND URGINIZATION

Despite the very high iron content (Ref.10) of the Korean diet, low blood hemoglobin levels are found throughout Korea. No hard data could be found for Seoul but hospital physicians assure the writer that blood hemoglobin levels average between 10% and 12% (United States averages 13.5%-15.5%). Beyond doubt the low blood hemoglobin levels in Korea, are the result of the heavy intestinal parasite infestation found throughout the country. In Seoul, anemia, resulting in lowered oxygen-carrying capacity of the blood, is of special importance because of the high carbon monoxide levels in ambient air and especially high levels in homes due to Ondol heating. Carboxyhemoglobin further lowers the oxygen-carrying capacity of the blood.

NUTRITION AND NUTRITIONAL DISEASES

According to a 1969 nationwide nutritional survey (Ref.10), the diet of Seoul citizens is richer in protein than that of most Koreans, except farmers. Nevertheless, the diet is marginal at best (79.5 grams protein, 2453 calories) and susceptibility to disease is increased under these circumstances. Given the increased probability of encounter with the tubercle bacillus resulting from increased crowding, and deficient ventilation of housing, it is not surprising that the incidence of tuberculosis is higher in Seoul than elsewhere.

Additional nutritional problems may be forthcoming as a result of the increased pollution of the shellfish beds, and

fall off in the fish catch proceeds along with increased contamination of the Han River resulting from urbanization. Contamination of food by insecticides, industrial wastes, etc. has been discussed elsewhere in this report.

NOISE POLLUTION

The Seoul Institute of Hygienic Laboratories has found increasing levels of noise pollution throughout the city (verbal communication). In 1971 the mean daily level of noise pollution in the city was between 75 and 80 decibels, while a 1969 study (Ref.17) showed mean levels of 65.9 decibels, but with peaks at the city center as high as 85.2 decibels (mean daily levels.) Such levels of noise pollution are not conducive to sound sleep and it is perhaps a fortunate situation that a midnight curfew has been in effect for many years. Studies in American cities reveal that noise levels, in this range, impair intellectual performance and decrease productivity. However sketchy the existing evidence in Seoul may be, it is impossible to avoid the conclusion that such high levels of noise diminish the quality of life wherever they occur, and very likely make inroads on the psychological balance and sense of well-being on populations subjected to them.

VENEREAL DISEASE

Urbanization and prostitution go hand in hand all over the world. The 1971 Statistical Yearbook of Seoul shows a definite increase of prostitution, but a diminished incidence

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of clinical syphilis admissions to Seoul city hospitals. However, another study (Ref.18) shows an increase in positive serologic tests for syphilis in otherwise normal pregnant women from 1.7% in 1959 to 6.9% in 1960. Also in 1966 a mass survey of presumed healthy soldiers showed an astoundingly high seropositive incidence of 10.9%.

The ready availability of penicillin in Korea is a confusing factor in attempting to analyse the pattern of syphilis in the country, but the consensus of physicians consulted, was that the disease is increasing nationally. The rise of syphilis has been accompanied by a gradual spread of the disease in the population. In a 1965 survey (Ref.19) it was shown that males infected with syphilis had contacted prostitutes in 22.2% of cases, business girls 22.2% of cases, female students 27.7% of cases and 27.7% with others. Health care is available to prostitutes and others for a nominal fee. Unfortunately there is no requirement for premarital serologic testing for syphilis.

The evidence suggests that syphilis is on the increase in Korea generally, in Seoul and other cities particularly, and an alarming trend toward distribution of the disease through the general public. Unfortunately there is no available data on gonorrhoea and other venereal diseases.

ACCIDENTAL INJURY AND DEATH

Mortality tables on page 4, Table 1, reveal an astonishing increase in deaths from accidents of all types (9.5% in 1966 to 18%) in 1968. Officials of the Ministry of Public Health and Social Welfare are deeply concerned about this problem.

One official told the writer that occupational illness, injury and death were his greatest concern, as industrialization in Seoul and throughout Korea advanced.

While the data base does not allow derivation of the incidence of motor vehicle deaths in 1966 and 1967, it is possible to ascertain that of all accidental deaths in 1968 (15%), motor vehicle accidents accounted for a full 4.7%. Ranked alone such deaths were the seventh leading cause of death in Seoul in 1968.

Police reports obtained by Professor Joseph Schofer indicate that from January, 1971 to November, 1971, there were 15,428 motor vehicle accidents in Seoul City, resulting in 541 deaths and 13,140 injuries, the vast majority of deaths and injuries being suffered by pedestrians. Undoubtedly Dr. Schofer's report will throw more light on this problem. However, it seems obvious that inadequate roads and sidewalks, inadequate traffic control, and increasing density of both motor vehicles and pedestrians are the principle causes of this tremendous toll on human health in the city.

A subway under construction is predicted to decrease traffic congestion when completed. The writer is not optimistic, since the increasing population, coupled with increasing income, suggests a trend toward increasing pedestrian density, and more privately owned motor vehicles.

MORBIDITY AND MORTALITY DUE TO FIRE

The writer was unable to find data from which conclusions on injury and death due to fire could be drawn. In the opinion

of many hospital and public health physicians, injuries and deaths due to fire have been increasing steadily over the past several years. Most of the morbidity occurs in slum areas where lanes are generally too narrow to permit access of fire fighting equipment. Pressure in the water mains is often inadequate and there is a shortage of fire fighting apparatus. The usual means of containing a fire, is to create a fire break, by tearing down housing around the fire center so as to prevent spread.

Other problems appear to be inadequate building codes and inadequate enforcement of existing building codes - even in major office and other buildings in the downtown section. The dreadful hotel fire of December, 1971, has given some impetus to a campaign for stricter enforcement of codes, public education on building evacuation, and updating of fire fighting equipment.

The Ondal heating system mentioned elsewhere in this report, in other health contexts, is probably the main source of fire in private dwelling units.

EMOTIONAL AND SOCIAL ILLNESSES

In almost every city in the Western World, where reliable data is collected, urban life is accompanied by a higher incidence of emotional and social illnesses. Unfortunately the data base in Seoul and Korea is insufficient to provide hard information in this area. A few trends can be seen, however.

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Neurosis and Psychotic Illnesses

The 1971 Statistical Yearbook of Seoul reveals hospital outpatient visits for patients with mental illnesses increasing from 241,109 in 1966 to 347,266 in 1970. Significantly the only category showing more visits was general illnesses (unspecified). When expressed as a percentage of total outpatient visits, the percentage of visits for mental illness remains steady at between 17% and 18% over the five-year period.

No data on the incidence of suicide, separation and divorce could be found. Child abandonment seems to have held fairly constant over the period.

With respect to criminal offenses the total incidence seems to have held approximately constant over the five-year period. Some offenses such as thefts declined rather markedly, others such as "cruelty" having increased sharply. The crimes of rape and homicide, forgery of identification papers, have also increased. Arrests for prostitution rose from zero in 1965 to 490 in 1970, while arrests for narcotic offenses have fallen from a high of 750 in 1966 to only 3 in 1970. No trends can be discerned.

No data on alcoholism is available, but Seoul physicians assured the writer that drunkenness and chronic alcoholism are becoming increasingly serious in Seoul. Similarly the incidence of hypertension is thought to be increasing, but no hard data is available.

THE BUILT ENVIRONMENT

One cannot visit Korea for more than a few days without realizing that prosperity by industrialization has become the goal of the people and their national government. The steady and rapid migration from the rural areas indicates that rural citizens are eager to partake of the new prosperity. Considering the very great disparity between incomes of rural and urban families, this eagerness is wholly understandable.

For the writer, what has happened in Seoul and other cities in Korea is illustrative of what is happening everywhere in the underdeveloped world. Seoul and Korea have, however, certain very special problems based on the geography and recent history of the nation.

The calamitous Korean War, following so quickly on the heels of a long period of exploitation during the Japanese occupancy of Korea, resulted in a virtually ruined countryside, and a population living the most marginal existence. It is not difficult to understand why environmental considerations have been (until recently) of low priority, while the new nation struggled to feed and care for its people. As one who has not experienced this kind of ruin and Phoenix-like rebirth of a nation, it would be presumptuous for the writer to attempt to guess when, before now, environmental considerations should have become a matter of concern. It is gratifying to see that such concerns are presently coming alive, especially in the academic and governmental sectors.

The tragedy of Seoul in 1972, seems to the writer, that the push to industrialization and economic independence is

resulting in a built environment. Geographical considerations of primary importance are that the country is politically separated from its own wealth of natural resources (in North Korea), and its remaining area is made up of 80% non-arable land. The strategy then, has been to create an industrial state in order to nourish an impoverished citizenry. To accomplish this the nation is gradually rebuilding what remained of the rural environment to support a gigantic industrial sector. For example, the development of the four river basins upstream from Seoul will alter the face of the land and displace many thousands of peasants. There seems to be, in this situation, a tragedy within a tragedy - in which industrial cities attempt to survive and grow - and in so doing, not only work further damage on an already war-ravaged countryside, but simultaneously degrade the urban environment. This helter-skelter creation of great cities at the expense of an all but ruined nation could, in blunt language, be termed parasitism. Of course it is easier to talk of problems than of their solutions. Following, the writer suggests some strategies for Seoul which it is hoped will have some relevance for developing cities in other developing nations, particularly those taking the road of industrialization, which demands the vehicle of great cities.

SUGGESTED STRATEGIES FOR REGIONAL DEVELOPMENT

A. Environmental Assessment

First of all a thoughtful and careful assessment of the general environmental situation, including evaluation of the nation's renewable and non-renewable resources, population, culture, customs, and traditions.

B. Determination of Style, Range and Scope of Development

With the results of the assessment of the nation's culture and environment in hand, best directions and most effective strands for development should be discernable. Economic, technological, and political considerations of every sort should enter into these determinations. It may well be, for instance, that careful deliberation will yield a plan for rural or recreational development, as being best for the region. Or perhaps an entrepreneurial system, such as has developed in Switzerland, or a special mix of industrialization, rural development and entrepreneurship as in Denmark.

C. Planning

When resources have been carefully weighed and directions carefully determined, developmental planning should be possible. The first principle of planning should be maximum development of resources consistent with balance of the ecosystem, which implies the health, welfare and viability of all components of the system. Also, implicit in this first principle of planning should be the understanding that development should work full benefits and

no hardships on the descendents, both human and nonhuman, animate and inanimate of the system. Such understanding can only develop out of conviction that all components of the ecosystem are interdependent. It is entirely possible that careful planning might call for total preservation of some sectors of a region, such as an absolute proscription of development of remaining forest lands. Contingency planning should begin at the outset and continue indefinitely.

D. Data Base

Out of the foregoing a reliable data base should develop, and the continuing input of information should be assured by careful monitoring and reporting systems, which do not neglect any measurable phenomenon potentially important for the viability of the whole.

E. Education of the Public

The writer is of the conviction that an enlightened public can effectively influence the decision process. Ideally an informed public would be the first requirement, since informed men of good will are indispensable to a protected environment. In the real world, an informed public is all too often one of the last sectors to be developed in any ecosystem. Nevertheless, the effort to create a thoughtful, informed and imaginative populace, should begin early and proceed continuously.

RECOMMENDATIONS FOR SEOUL

The proposals made in the preceding section have less applicability for Seoul, since this city has already developed to such a great extent. Nevertheless, the writer urges some attention be given them, where they may be relevant. The following recommendations may be more useful at present or in the near future.

1. Development of monitoring systems, particularly for the following:
 - a. Air pollution (CO, SO₂, NO₂, lead, etc.)
 - b. Han River pollution (dissolved O₂, enteric pathogens, industrial pollutants, etc.)
 - c. Soil pollution (pesticide and herbicide use, fertilizer use, soil oxidation and run-off, etc.)
 - d. Estuary pollution and fishery inventory.
 - e. Population movement (towards the city and within the city)
 - f. Meteorological and river flow data.
2. Development of a firm reporting system for human illness and injury. Adequate data processing equipment is essential equipment.
3. Development of communication lines between all Seoul City and National agencies involved with environmental and human health concerns.
4. Strengthening of the National Institute of Health, committing sufficient funds for vigorous and well-equipped laboratories and a well-trained corp of environmental and public health professionals, including sanitary and other engineers, air

pollution and water pollution experts, epidemiologists, and general ecologists.

5. Perhaps a reorganization of national agencies, such as led to the creation of the United States Environmental Protection Administration would be the best approach to items 3 and 4. Provisions for training manpower for present and future needs, in cooperation with the university sector, should be made.
6. Road and street improvement, including pedestrian lanes.
7. Extension of sewage systems so as to reduce deposition of human excrement in streams, eliminate dug privies and night soil collection as rapidly as possible.
8. Development of interim night soil treatment systems adequate to prevent transmission of enteric disease.
9. Serious consideration should be given to supplying the city's water treatment plants with water carried by aqueduct from water impoundments upriver from the city. Protection of impounded water from pollution by sewage, run-off from agricultural lands, and industrial wastes should be assured.
10. Improved water distribution system. The system should at all times be under sufficient pressure to prevent back-pressure contamination, and allow assured pressure for fire fighting equipment.
11. Consideration should be given to means of preventing automotive traffic congestion in commercial areas where pedestrian traffic is heaviest. Perhaps a scheme of tax disincentives could be developed in order to reduce the

number of private passenger vehicles in congested areas and to pace the availability of passenger vehicles to correspond with developing road and street capacities. Motor vehicle emission standards should be explicitly legislated, and rigorously enforced.

12. Consideration should be given to the establishment of open space throughout the city. As buildings are condemned, the resulting land space could be committed for parks and other recreation use. As close-in farming is gradually eliminated, the land could be committed for open space.
13. Location of new buildings, industrial and commercial establishments should be regulated by explicit legislation. Industrial emission standards should be similarly established and enforced. Tax incentives, for location of industry away from the city, are possible.
14. Premarital serologic tests for syphilis should be required by law. Means for venereal disease detection and control among prostitutes and entertainers should be developed. Serologic tests on all school children would be an important step in detection.
15. Strengthening and extending tuberculosis detection and treatment capability.
16. Alternatives to Ondol heating method should be carefully researched. This is a matter of the highest priority in the protection of health and safety of the people. As an intermediate strategy, improvement of Ondol heating to protect dwellings against carbon monoxide accumulations, may be possible.

17. Legislation bearing on industrial health and safety should be strengthened and rigorously enforced.
18. Methods for discouraging migration from rural communities should be explored. Tax incentives may be effective, along with improvement of income and living conditions in rural areas.
19. The population planning program (already yielding good results) should be strengthened, especially in rural areas.
20. Systems of automotive traffic control should be strengthened.
21. Stronger building codes, especially with respect to fire safety, should be developed and rigorously enforced, building operation and maintenance should be subject to rigorous monitoring and enforcement.
22. Sanitary codes and licensure requirements for restaurants, markets and food processing plants should be developed, and inspection procedures adequate to insure safety should be strengthened. Measures to eliminate unlicensed food vendors should be taken.
23. Development of systems for equitable distribution of health care throughout the city and the nation should be pursued, along with strengthening public health and preventive medicine facilities. Perhaps the most practical strategy for improvement of health care would be the development of a corp of intermediate health care professionals.

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PERSONS CONSULTED

1. Dr. Newman Hall, USAID
Mr. Dallas Hunter, USAID
2. Mr. Lim, Song Ki; Environmental Section Chief, Health and
Social Affairs Bureau, Special City of Seoul
3. Dr. Huh, Young; Prof. of Health Administration) School of Public
Dr. Kim Chung Kun; Prof. of Biostatistics &) Health, Seoul
Ecology) National Univ.
- * 4. Dr. Kwon, Suk Pyo; Prof. of Environmental Health, College of
Medicine, Yonsei University.
5. Dr. Lee Song Hi; Director Public Health Bureau, Ministry of
Health and Social Affairs.
6. Dr. Yang, Jae Mo, Professor, Medical School, Yonsei University
7. Dr. Kim, Il Soon; Prof., Dept. of Preventive Medicine,
Yonsei College of Medicine
8. Dr. Kim, Kiho; President Korean Academy of Tuberculosis,
Yonsei College of Medicine
9. Dr. Lew, Joon; Prof. of Microbiology, Yonsei College of
Medicine
10. Dr. Chin, Thack Loh, Prof. of Parasitology, Yonsei College of
Medicine, Director of Institute of Tropical Medicine
11. Dr. Rhee, Chonjuh; Head of Environment Studies Group, KIST
12. Dr. Whang, Kyo Bok; Leader Transportation Economics Group,
KIST
13. Dr. Hahn, Sang Joon; President KIST
14. Mr. Rhee Choong Sheek; Chief of National Nutrition Office,
Ministry of Health and Social Affairs.
15. Mr. Shin, Kyong-Shick; Chief Waterworks & Sewage Division,
Ministry of Construction
16. Dr. Kim, Jong Kun, Prof. of Biostatistics & Human Ecology,
School of Public Health, Seoul National University
17. Dr. Roh In Kyo, Prof. of Epidemiology, School of Public
Health, Seoul National University
18. Mr. Kim, Hiyosang; Chief Public Nuisance Measurement, Seoul
Institute of Hygienic Laboratories.

Persons Consulted (Cont'd)

19. Richard H. Harris; Sanitary Engineer, World Health Organization
20. Mr. Donald Thomas, AID, United States Mission
21. Mr. Donald Reilly, AID, United States Mission
22. Mr. Carl F. Bartz, Jr.; First Secretary (Cultural) American Embassy, Korea
23. Mr. Keith Chriastion, Urban Planner, Korea Institute of Science & Technology

VISITS, TOURS AND INSPECTIONS

Tour along Han River to view sewage outfalls, water treatment plant intakes.

Trip to countryside village, Duk Chon, Hwacheon Province. Viewed several dams on Han River and tributaries. The largest dam in Korea was built by Japanese in 1930's (Hwacheon Dam) and displaced 60,000 people. A large multipurpose dam under construction, Soyang River, will displace 70,000 (circa). Also viewed Chumpyung Dam on Han River.

Trip to Incheon to see industrial corridor, fishing industry and potential for development. (Water supply comes from Seoul.)

Visit to Korean National Institute of Public Health.

Accompanied night soil collection truck, observing collection from privies and delivery to orchard. Also inspected one of large night soil repositories from whence soil is bagged and sold to farmers.

Tours of retail produce markets (meat, fish, vegetables and other food items).