

Aeronautics and Astronautics. The findings reported here were selected from a series of studies in which data were collected on over 30,000 scientists, and the statistics presented are averages (medians) of data collected in the study of the social and physical sciences. Data for the engineering sciences are not given, as those studies are continuing. The American Psychological Association (APA) has made similar studies in the area of psychology. When appropriate, we compared the APA data with our data. Apparently the dissemination process for psychology is similar to that for the social sciences we studied.

4. In a study of authors of presentations at national meetings, the Center obtained data on the journals to which these authors planned to submit manuscripts based on their presentations. The Center made citation analyses based on the journals mentioned most often and on journals published by the societies sponsoring the meetings. The Center analyzed references

found in the issues of these journals that had been published during the previous 2 years, and included analyses of references from the journals most often cited in the first group of cited references. This process was continued for meetings of each of the nine societies of the study until a point of diminishing returns had been reached—that is, until the journals that remained could not be considered to be in the mainstream of the discipline's journal literature. Such analyses, for the various disciplines in the Center's program, indicated that (i) a small number of journals have a central, or "core," position in the discipline's literature; (ii) a slightly larger number of journals relate peripherally to this "core" literature; and (iii) a large group of journals are loosely associated with this "core" literature.

5. These were people reported by the authors to be conducting work in the areas discussed in their articles—that is, work deriving from the authors' findings, stemming from the same con-

ceptual or theoretical framework as their work, attacking the same problems from different points of view, stimulating their work, and so on.

6. In its study of meeting attendants the Center obtained a random sample of persons attending sessions at the meetings. In the questionnaire used to study this sample each attendant was asked about four sample presentations that had occurred during the session in question.
7. The Research and Studies Section of the Office of Science Information Service of the National Science Foundation (NSF-GN514) supported the work reported here. Kazuo Tomita, Gayle Rummel, and Barbara Pajak contributed significantly to the work reported, and Cheryl Barnett helped to prepare the manuscript. Details of the work may be obtained from the series of reports produced by the Johns Hopkins Center for Research in Scientific Communication.

## The Mao Ethic and Environmental Quality

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It is only recently that apprehension over the rapidly intensifying problems of environmental quality in the industrialized world has reached a point where it has become obvious that solutions will require much more money, effort, and desire on the part of both government and people. It may come as something of a surprise, therefore, to find that as early as the 1st century B.C. the Chinese *Record of Rites of the Elder Tai* (1) warned against man's polluting his environment, and that Communist China, at best only a partially industrialized nation, has shown some concern regarding questions of environmental quality for almost all of the 20 years of its existence. Taking great satisfaction in their professed accomplishments in this field, the Chinese news sources have been quick to report and comment on U.S. problems of pollution, citing them as among the more serious weaknesses of the capitalist system. They even referred to President Nixon's State of the Union Message, commenting that he "helplessly wailed that [in 10 years] the so-called 'pollution' problem in the United States would 'become insoluble'" (2). They have also pointed to reports in the *Wall Street Journal* that the production of antipollution devices has become

the new "glamor industry," stating that American antipollution programs are a guise for further exploitation of the American people by "monopoly capitalists" (3).

### Setting for Chinese Environmental Concerns

The fight against environmental contamination in Communist China, which has taken various forms over the years, was recently manifested in the ideological struggles of the now waning Cultural Revolution—the struggle between the all-powerful thoughts of Mao Tse-tung and the black deeds of Liu Shao-chi, the former President of the People's Republic of China, who took the "capitalist road." Liu, as politician and development strategist, has often been identified by the Maoists with China's "bourgeois experts"—those managers, engineers, and scientists whose positions in the technically oriented bureaucracy implied the emergence of a technocratic elite. Thus it was not only Liu but also the "experts" and all they represented in terms of economic growth and social modernization that became subjects for attack during the Cultural Revolution. According to

Maoist news sources, the approach of Liu Shao-chi and the technical experts toward industrial wastes was to treat these as "industrial 'garbage,' . . . [maintaining that] because they could not be reused to produce large quantities of valuable products, it would not pay to utilize them. They [Liu followers] not only threw away these valuable materials, but let them pollute the air and rivers" (4). Thus "Liuism" has come to represent a position of opposing the comprehensive utilization of resources, of relying on the opinions of experts, and of being insensitive to environmental pollution.

Maoism, on the other hand, is first and foremost an ethic of frugality, of "doing more with less." It is an ethic of self-reliance, but of self-reliance tempered with the cooperation that theoretically results from the mobilization of all sectors of the society for given tasks. Maoism is an ethic of progress, but of progress that relies more on the transformation of the Chinese masses than on the directions and recommendations of a scientific and technological elite. Hence, progress and the resulting changes in the means of production—the development of new technologies—are to remain under human control. It is therefore an ethic that appears to make technological development dependent on social development, instead of letting social development slip completely out of phase with technological progress. As an environmental ethic, then, Maoism may seem very attractive indeed to many of the citizens of the complex industrial societies of the West, who are increasingly disturbed about the secondary and tertiary ecological effects of their technologies.

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When the Communist Party seized power in China, the new regime established as two of its primary goals "socialist construction" and "national defense." In some respects both these goals entailed new relationships between man and nature. Attitudes of the new regime toward the natural environment, although this is rarely explicitly stated, were, on the one hand, necessarily exploitative and, on the other hand, curative. Nature was to be exploited for the good of society, and the fostering of modern science and technology was considered an appropriate means to that end. Yet, the vastness of China's population and the primitive exploitation of nature that characterized the old society had resulted in a highly degraded environment which manifested itself as totally inhospitable in time of famine, plague, or flood. Therefore, in addition to exploitation, there was a need for therapeutic action in such areas as afforestation, water conservancy, land reclamation, and sanitation and public health.

To increase their inadequate knowledge of the nation's resource base and natural environment, the Chinese leaders promoted a rather extensive series of surveys of tropical resources in south China. These activities became known as "comprehensive expeditions" and were often conducted in collaboration with Soviet scientists. More than ten of these highly organized multidisciplinary expeditions were made during the 1950's. The foci of the expeditions ranged from water and soil conservation surveys in the middle reaches of the Yellow River to surveys of tropical resources in south China; from studies of the developmental potential of the Amur River basin to studies of the feasibility of developing water resources in west China. The composition of the expedition teams varied according to task and location, but the teams typically included geographers and geologists, hydraulic engineers, pedologists, foresters and agriculturists, and public health officials (5).

These attempts to explore and inventory China's natural environment were institutionalized with the establishment of a high-level Committee on Comprehensive Expeditions, within the Chinese Academy of Sciences. This committee, with meteorologist Chu K'o-chen as chairman, was established in 1956, the year in which the long-range, 12-year plan for the development of science and technology was initiated. The committee had responsibility not only

for promoting the expeditions themselves and for coordinating them with the Soviet Union but also for producing, on the basis of the data obtained, reports and plans for the exploitative and curative environmental management of the regions studied. Although the final disposition of these plans is unclear, presumably they formed the basis for subsequent planning and development in many regions of China.

At a different level, the responsibility for research on specific measures designed to improve the environment, and for their implementation, was distributed among numerous institutions. The Ministry of Public Health had perhaps the major share of the total responsibility, since much of the emphasis was on the health and well-being of the workers. But some of the most important research on pollution was conducted in the Ministry of Labor's Institute of Scientific Research on Labor Protection, in the Division of Research on Labor Sanitation of the Chinese Academy of Medical Sciences, and in other such institutions. There were also special research institutions in the research organizations of the ministries of Metallurgy, Coal, Chemicals, Railways, and Construction, and departments and special courses on labor protection in many universities and colleges (6). Thus, to use one of their favorite expressions, the Chinese Communists attacked the environmental problem "on many fronts."

### Human Pollution

In the past, health conditions in China have been notoriously poor, and, for most of the people, sanitation measures virtually unknown. As a result, the death rate tended to fluctuate between high and very high, depending on the extent and intensity of famines, natural disasters, military conflicts, and epidemics of such "filth diseases" as typhus, cholera, plague, typhoid, and dysentery. Improvement of the health of the Chinese population was high on the priority list of the Chinese Communists. Since there were not enough doctors and medical facilities to provide medical care for those who were sick, emphasis was concentrated on preventive medicine and on environmental sanitation, so that the number of people requiring medical attention would be reduced. Through massive programs of vaccination, through periodic nationwide "patriotic health campaigns," and through

concurrent long-range campaigns to control kala-azar, schistosomiasis, hookworm, malaria, filariasis, and other diseases, the Chinese have achieved considerable success in improving the environmental conditions and, consequently, the health of the population.

A feat that has received much publicity in the West has been the elimination of flies and mosquitoes through the mobilization of virtually every man, woman, and child in the country. It seems quite possible that the Chinese may have gone a long way toward accomplishing another feat of almost equal proportions—that of cleaning up many of the polluted streams, small rivers, and lakes which for centuries have been receiving much of the human and animal waste that was not used for fertilizing fields. Careful management of water and manure in the rural areas is one of the most important functions of medical and sanitation personnel, while medical and public health journals publish many articles on the subject and print detailed instructions on how to build and protect wells, how to manage manure, where to place latrines, and what personal hygienic measures one should take after working with manure.

Since many of the cities in China continued to have inadequate sewerage systems or none at all, the Communists concentrated much effort on the proper disposal of human waste in the more densely populated areas. In order to control contamination of urban water, which usually came from adjacent rivers or lakes, the Chinese adopted a twofold approach. First, over the years the Communists made considerable progress in expanding urban sewerage and sewerage treatment facilities; second, much of the urban waste was transported into the countryside to be used for the irrigation and fertilization of farms. The latter process undoubtedly helped the cities but apparently intensified health problems in the villages. Reports indicated some serious increases in the incidence of dermatosis and various infectious diseases. These reports were followed by increased discussion of problems and of possible solutions in the public health and sanitation publications.

Other pollution problems in the cities were handled through extensive clean-up campaigns—not unlike recent community efforts in some of the cities of the United States, but on a vastly larger scale. Masses of people were mobilized in China's cities to remove refuse that had accumulated in resi-

dential districts. To keep the streets and alleys of residential areas clean, regulations that such areas must be swept were enforced, and residents were organized to transport refuse. In this process great care is taken to salvage anything that may have some residual value. For example, pieces of metal are always collected; furnace cinders are gathered, to be used in construction materials or as fill for swampy areas; and so forth. A side effect of the "keep your city clean" campaigns, Chinese style, is one that foreigners who had been in China prior to 1950 would find almost unbelievable: apparently the people no longer expectorate or blow their noses on the street.

To judge from the periodic introduction of new clean-up campaigns, however, the authorities have not been able to rest on their laurels, since people tend to slip back into old habits. After almost 3 years of the Cultural Revolution, much space in the Chinese press was given this year's spring cleanup, which was described as a "spring patriotic sanitation movement." It was organized by local revolutionary committees and focused on picking up accumulated litter and garbage from residences, farms, and factories; on cleaning up local waters; on eliminating pests; on collecting reusable wastes; and on stressing public health measures.

### Industrial Pollution

Throughout the period of the Peking regime, industrial pollution has been fought primarily under various slogans relating to frugality; workers have been told that, if they will properly implement Mao's thoughts, "wastes" will indeed be transformed into "treasures." Of particular importance during the last few years has been the concept of "comprehensive use," introduced as a Maoist injunction to workers and peasants to recover and reuse (recycle) industrial and agricultural wastes. Although the comprehensive-use concept had its foundations in perceived conditions of scarcity and in Maoist frugality as a response to those conditions, it has nevertheless been explicitly linked to environmental quality. During the first 4 months of 1970 the tempo of the comprehensive-use campaign increased. The campaign became a "vigorous mass movement" aimed at full utilization of the "four wastes"—waste materials, waste water, waste gas, and waste heat. There are indications that Chinese sci-

ence and technology is being asked to focus more of its attention on comprehensive utilization (7). This presumably will lead to research by trained scientists and engineers on the recycling of resources, to supplement the innovations of peasants and workers.

It is easy to understand why China would not be greatly concerned with air pollution. First, only about 15 percent of the population is located in the urban areas and only a small proportion of the urban labor force is engaged in industrial production. Second, pollution from automotive traffic is insignificant in Chinese cities. This is not to say that air pollution does not exist in some of China's more important industrial centers, or that serious pollution problems are completely ignored. Steel centers such as An-shan and Pao-t'ou and large industrial centers and urban conglomerations such as Shanghai, Tientsin, Harbin, Wuhan, and Peking certainly produce their share of air pollution and cause local concern. For example, a clinical examination of school children conducted as part of research on the effects of atmospheric contamination on the health of people living near the Shih-ching-shan Steel and Iron Factory in Peking revealed definite liver enlargement that was attributed to the toxic effects of the small amount of sulfur dioxide in the atmosphere (8).

To cope with some of these problems, many of the old cities such as Peking, Shanghai, and Wuhan have reportedly relocated those factories that seriously contaminate the atmosphere, moving them to new industrial zones. In many of the new cities factories are being built "on the opposite side of the city from which the wind usually blows."

Some of the factories report making "wealth" from waste gases (8):

At the Dairen Chemical Factory, in the process of manufacturing sulphuric acid, extra gas from the surplus acid was usually expelled directly into the atmosphere. This condition endangered the health of the inhabitants. . . . Now this company is recovering sulphuric acid fumes and ammonia, and producing fertilizers with these waste products.

Much progress has apparently been made in improving the working conditions of those involved in mining and other industries where harmful dust is prevalent. For example, it was reported that the concentration of silica dusts in metal mines has been reduced to meet government standards and that similar

progress has been made in controlling dust in coal mines, chalk factories, quartz factories, and enamelware factories. As a result, diseases such as silicosis have been drastically reduced (9).

Because the consequences of water pollution are much more immediate and serious, the industrial pollution of water is naturally more disturbing to the Chinese Communists than air pollution is. With increased industrialization and urbanization, both the nature and the degree of water pollution changed for the worse. As in the case of air pollution, however, the ameliorating factor is the concentration of most Chinese industry in less than a dozen eastern and northern provinces.

An effort is made in most cities to locate new plants and factories downriver from the most densely inhabited areas. Furthermore, the more modern and the larger installations may well have some waste-water purification systems. The most serious problems undoubtedly relate to the older and the smaller industrial facilities, which continue to dump untreated industrial waste into adjacent bodies of water. It seems doubtful that even the expanded sewerage facilities now being constructed in some of the cities can keep up with the increasing industrial development and the concurrent growth of urban populations.

The impression one gets from various articles and reports appearing in the Chinese press is that, even as in Western countries, there is an inevitable gap between identifying the sources of pollution and doing something about it. Epidemiological departments of many cities and provinces report much research on the quality and cleanliness of the water in rivers and lakes. There has been considerable research, experimentation, and collection of data by various scientific and educational institutions. Given China's economic constraints, however, the admonitions of the health and sanitation departments are not likely to result in corrective action unless the waste is particularly harmful, unless the cost of corrective action would be minimal, or unless the waste can be made economically profitable.

All three of these considerations may be discerned in recently reported activities in Shanghai, China's largest and most industrialized city. In July 1968 the Shanghai Municipal Revolutionary Committee—the effective local government, made up of representatives from

the army, unpurged Party cadres, and revolutionary activists—started a campaign to clean up the waters of the Huangpu and Suchow rivers. In the course of Shanghai's industrialization, these two streams had become industrial sewers, with plants for paper manufacture, printing and dyeing, chemical-fiber manufacture, electroplating, tanning, and other industrial processes located on their banks. The campaign appeared to have economic, environmental, and sociopolitical objectives. Much of the justification for the work which ensued was based on the concept of comprehensive use of resources. It was noted that most of the raw materials for Shanghai's industries came from distant sources. In the interest of economy, therefore, "workers, revolutionary cadres and revolutionary intellectuals" were urged to make thorough use of these resources. Wastes were to be recovered and recycled for further industrial use where possible, or waste waters were to be diverted for irrigation of farmlands in the vicinity of the city. Efforts were made to develop new technologies for these purposes. This was reported in the electroplating industry, for instance, and also in a gas factory which was producing waste waters that were heavily contaminated with phenol. In attacking this pollution, it is claimed, new equipment for recovering the phenol was developed and installed at a modest cost (10).

These efforts at comprehensive use were also seen as improving the quality of the environment. It was recognized that the reduction of stream pollution not only improved the appearance of the rivers but also represented a major step forward in sanitation and public health. Efforts were made to dredge the rivers of contaminated muck. The Revolutionary Committee used the standard Chinese Communist technique of mass mobilization for this purpose. Over a 3-month period, "90,000 persons were mobilized on the industrial and agricultural fronts in Shanghai to form muck-dredging and muck-transporting teams, waging a vehement people's war to dredge muck from the Suchow River. After 100 days of turbulent fighting, more than 403,600 tons of malodorous organic mire had been

dug out" (10). Most of this was to be used as fertilizer.

There are two basic reasons why the Chinese Communists seem to have been concerned with environmental pollution when the more advanced and more polluted countries of the world were still largely ignoring the problem. First, the concern was an integral part of China's efforts to improve the country's health and sanitation conditions; second, it was consistent with the Chinese Communists' policies and programs of frugality and economy.

Chinese environmental problems have been characterized by the fact that a great proportion of waste in China is organic. There are no unreturnable containers, few plastic goods, no car cemeteries—none of the wastes of our affluent society. On the contrary, because of the low economic level of the population and the national emphasis on frugality, few items are disposed of unless they are approaching a natural state of disintegration. Thus, for most of China, solutions involve intensification of sanitation measures, mass clean-up campaigns, and other measures of the "do-it-yourself" variety. In the areas of industrial pollution and urban sewerage disposal, however, the problems are much more serious, and, despite considerable progress and continuing efforts, many undoubtedly persist.

Underlying present Chinese concerns about pollution are the thoughts of Mao Tse-tung. Maoism as an environmental ethic may strike many Westerners as obvious common sense. In the real life of contemporary China, however, it is still an open question whether the Maoist ethic represents common sense or courts environmental catastrophe. However admirable the attempts at comprehensive utilization and recycling of wastes may be, there are indeed occasions when such efforts make no economic sense and may make even less ecological sense (11). The removal of labor from productive activities for purposes of diverting industrial waste waters for irrigation is a case in point. These waters may have a highly deleterious effect on the irrigated fields. Unfortunately, we lack information on whether or not this process is scien-

tifically monitored, whether the waste waters have been chemically analyzed, and whether the wastes in them conform to the needs of the soils.

Similarly, the encouragement of inventiveness on the part of workers and peasants and maintenance of a skeptical attitude toward "academic authorities" are in many ways eminently reasonable policies in a developing nation. However, the widespread discrediting of the expert can also have unfortunate consequences, particularly in areas of ecology where expert scientific knowledge is critical.

All conclusions with regard to developments in China these days come by way of piecemeal facts and wholesale speculation, and pollution control is no exception. It seems, however, that a summation from a 1959 Chinese medical journal is just as valid today as it was 10 years ago (12): "Since the founding of new China, great achievements have been made in the research and practical work in the field of environmental hygiene. . . . Nevertheless, our achievements are far from meeting the requirements of socialist construction in our country."

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