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REPORT ON CHINA STUDY TOUR

By

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This is an account of the experiences obtained and observations made during a study tour to the People's Republic of China, organized by the United Nations Environment Programme (UNEP), to study pollution-free methods of small-scale energy production.

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## PRESENTATION

The United Nations Environment Programme (UNEP) is studying the environmental consequences of developing energy resources, whether renewable or not. These mainly include hydropower generation, geothermal development, oil and nuclear fired thermal generation, coal and wood burning, and biogas utilization.

As part of an overall cooperation programme with the People's Republic of China, the UNEP organized a group of experts to study the achievements of that country in the field of pollution-free energy development through the use of small hydropower projects and biogas generating units. The group of experts would travel throughout China, making on-site observations of such systems, to determine the feasibility of transferring the Chinese experience to their respective countries.

The writer - Assistant to the ECLA Mexico Office Director - was selected to join the team of twelve experts, and travelled extensively through China between 24 September and 19 October 1976. This report presents the results of the writer's observations and recommendations in regard to the energy and environment field. In addition, a series of descriptions, conclusions and recommendations are made in connection with the general living, economic and social conditions of China; these are necessarily sketchy in nature, but are considered useful in view of the interesting features of such a country.

## I. INTRODUCTION



## I. INTRODUCTION

### 1. General

The production of energy, while essential to assure economic and social development, usually results in pollution of the environment. The degree of environmental degradation of the energy producing process, depends on the nature of the energy source and the procedure for its development.

The generation of energy through burning of oil derivatives, mineral fossils and nuclear material, is a non-renewable process and results in pollution of the atmosphere and of the nearby water bodies. The cutting of wood for use in energy generation, for cooking and lighting purposes, is detrimental to the environment as it brings about deforestation, soil erosion and even micro-climatic changes.

The development of hydroelectric resources, while considered a renewable process, may also result in microclimatic modifications due to the creation of a larger water surface area, and in the undesirable retention of silt and nutrients at the dam site, thus harming downstream agricultural production. The harnessing of geothermal energy resources may significantly alter the hydrological regime of a river basin, specially its ground-water balance, and may even result in water quality changes due to the high temperature and undesirable salt contents of the discharged water-vapor mixture, if not reinjected.

There exists, therefore, a very special need for studying the best means of developing energy sources under different sets of conditions, with the least possible damage to the environment. While other United Nations' agencies are responsible for the research and direct development of energy, the United Nations Environment Programme is concerned with the aforementioned task.

### 2. Purpose and scope of the study tour

Acting upon a resolution of its Governing Council, the UNEP's Executive Secretariat decided to include within a broad cooperation program being

/undertaken

undertaken with the People's Republic of China, the implementation of a study tour which would:

- i) Examine the results of the Chinese efforts of small-scale energy development by means of low pollution procedures, and
- ii) Determine whether the Chinese experience, if found to be successful, could be transferred or adapted to the conditions of other developing countries.

More specifically, the study tour would be focused on examining the development of small-scale hydropower developments for electrification of villages not necessarily connected to the national or provincial grids, and on the generation of methane through the "biogas process"<sup>1/</sup> for cooking and lighting purposes in isolated rural communities. It was felt that these small-sized schemes were low in pollution and allowed the villages to become self-sufficient in energy production.

Since the development of hydro-energetic sources entails the possibility of multi-purpose utilization of water, the study tour also involved the analysis of the Chinese experience in irrigation, flood control, navigation, fish breeding and other similar undertakings.

In addition to the above, the ECLA Mexico Office decided to take advantage of the fact that one of its staff members would travel extensively throughout the People's Republic of China, to learn about its achievements and methods of planning and implementation of social and economic development programmes.

### 3. Composition of the Mission

For the Study Tour a Mission of twelve experts was organized, comprising both United Nations staff members and advisors and top-ranking government officials from both developed and developing countries.

<sup>1/</sup> As will be explained in detail later on, the biogas plant utilizes available human and animal excreta, together with water and vegetable waste, to generate methane gas through a fermentation process which is virtually pollution-free and allows the side production of organic fertilizer for agriculture.

The group was integrated as follows:

**A. United Nations officials:**

- 1) Bruce Stedman, Deputy Executive Director, UNEP, Mission Leader.
- 2) Wo-Yen Lee, Special Assistant to Executive Director, UNEP.
- 3) Essam El-Hinnawi, Senior Programme Officer, UNEP.
- 4) I. H. Ussmani, Senior Energy Adviser, UNEP.
- 5) J. Roberto Jovel, Assistant to the Director, United Nations ECLA Mexico Office.

**B. Government officials:**

- 1) Jelani G. Jelis, General Director of Energy, Ministry of Planning. Kabul, Afghanistan.
- 2) Peter Haines, Senior Energy Adviser, Canadian International Development Agency (CIDA). Ottawa, Canada.
- 3) Jacques Martinod, Executive Director, Institute of Water Resources. Quito, Ecuador.
- 4) Ossi Hjelt, Director, River Planning Bureau, Ministry of Agriculture. Finland.
- 5) Charles Quansah, Principal Economic Planning Officer, Ministry of Economic Planning. Accra, Ghana.
- 6) Alexander Diacon, Dean, Faculty of Hydroenergy, Polytechnic Institute. Bucarest, Romania.
- 7) Mamadou Diop Gaye, Chief, Technical Officer of Coordination and Cooperation, General Directorate of Hydraulic and Rural Works. Dakar, Senegal.

**4. Schedule of the tour**

The tour officially began on 27 September and ended on 18 October 1976. It included a stay of seven days in Peking, the nation's capital; a visit to Shanghai and to the provincial capitals of Kwanchow and Changsha; and detailed tours of three districts and more than six counties.

Altogether, the Mission travelled a total of slightly less than 6 000 kilometers, by airplane, train and automobile. (See figure 1.)

The following is an itemized description of the Mission's itinerary:

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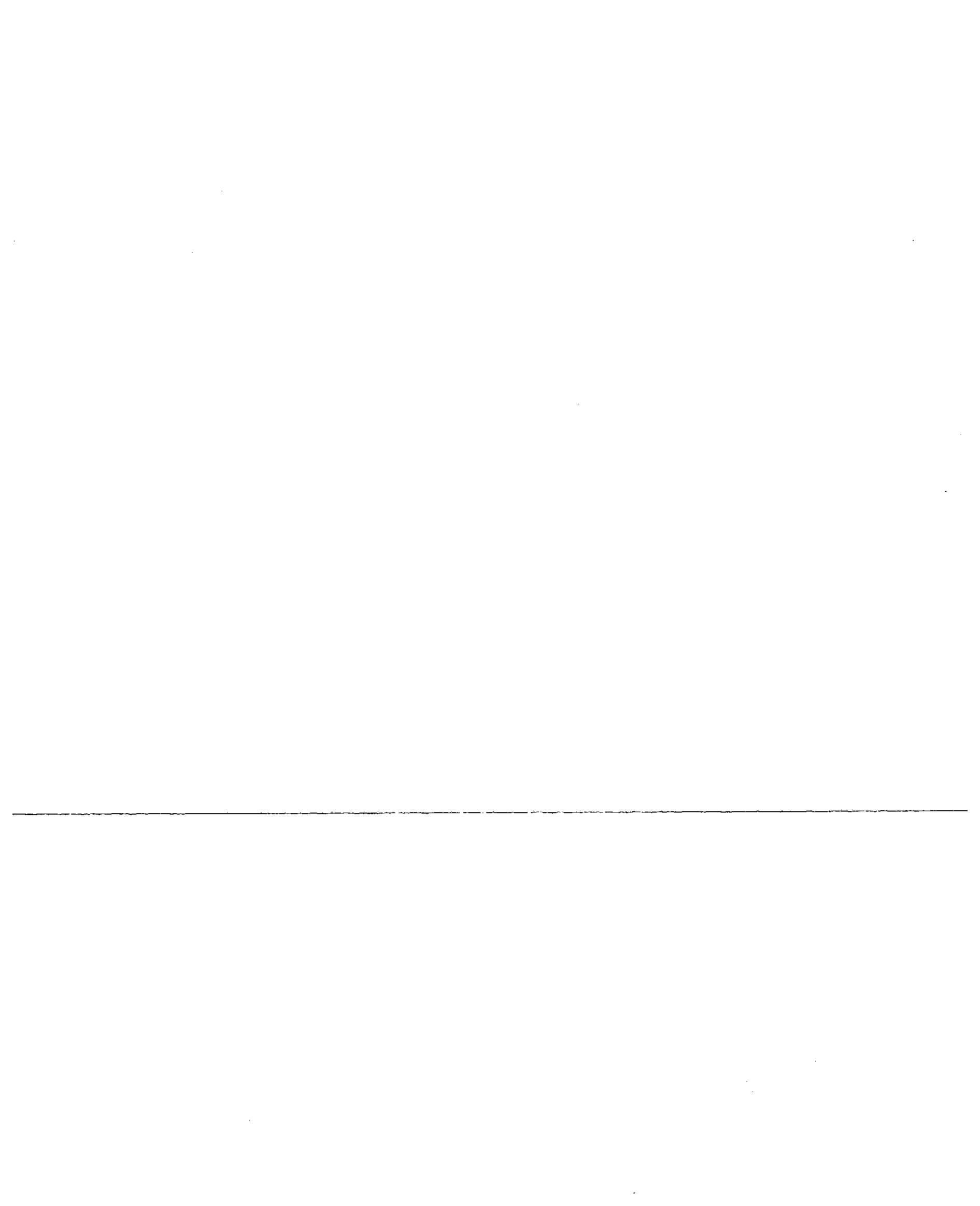
<u>Date</u>	<u>Place</u>	<u>Activities</u>
September 24	Peking	Arrival to Peking at night.
September 25	Peking	Tour of the Forbidden City and the Ever-Green Agricultural People's Commune.
September 26	Peking	Visit to Peking's Small and Medium Size Equipment Factory. Tour of Peking and surroundings.
September 27	Peking	Visit to the Temple of Heaven. Visits to the Water Conservancy Construction Hall, and to the National Agricultural Exhibition Center.
September 28	Peking	Visit to the Great Wall and the Underground Palace; tour of the Ming Tomb reservoir. Introductory talk on small hydropower project construction in China, by an engineer of the Ministry of Water Conservancy and Power. Left Peking for Linhsien County, Honan Province, by train.
September 29	Linhsien County	Visit to the Museum of the Yin Dynasty ruins, and to the Red Flag Canal Exhibition Center. Field visit to the Youth Tunnel, the Nankutung reservoir and the Taihang Traffic tunnel.
September 30	Linhsien County	The confluence of the Red Flag and the Heroes canals, and hydropower station. Visited 23 small hydropower plants along a length of 8 kilometers of a branch canal. Examined a biogas plant in a small village. The Dawn tunnel, pumping station and aqueduct.
October 1	Chengchow	Travelled to Chengchow, the capital of Honan Province, by train. Visited Mangshan Pumping Station. Briefing on the Yellow River harnessing and development. Train to Shanghai.
October 2	Shanghai	Bird's-eye view of the city and tour.
October 3	Shanghai	Tour of the Shanghai Industrial Exhibition Center. Visit to the China Electric Equipment Plant.
October 4	Shanghai	Visit to the Shanghai Graphite Electrode Factory. Afternoon flight to Kwanchow.

# SKETCH MAP OF CHINA



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Figure 1. Sketch Map of People's Republic of China, showing itinerary of UNEP's Study Tour.-



<u>Date</u>	<u>Place</u>	<u>Activities</u>
October 5	Kwanchow Tsunghua County	Tour of the National Institute of Peasant Movement and the Martyrs Mausoleum. Study of the Linhsi River irrigation project. Visits to Linhsiho dam and hydropower station; the Wuchihshan third and fourth stage power stations in Liangkou People's Commune; and the Youth hydropower station.
October 6	Tsunghua County Huachien County	Visits to the Man-made Lake Antirevisionism Power Station, and to the Tienhu Power Station. Visit to the Lihsi River Power Station and to a small hydropower plant on an irrigation canal; to a farm-machinery and farm-product processing plants; to the agricultural experimental station and to the hospital in Huatung People's Commune. Return to Kwanchow by car.
October 7	Hsinhui County	Trip to Hsinhui County, by car. Tour of the Hsinhui Farm Machinery Plant (which produces walking tractors), the Hsinhui Palm Arts and Crafts Factory and the Labourers University.
October 8	Hsinhui County	Study of the cascade development on the Kutou mountains. Visits to Tungfanghung Dam and Power Station in Yanan People's Commune; to the fourth and fifth stage power stations located along main stream and to the second power station on the branch stream. Observation of a land reclamation from the seashore scheme. Tour of the cascade development of Hokeng Power Station, Erhtaitang Reservoir, second Lotung Power Station, and the Vanguard Hydropower Station (10 kw) in Yahsi People's Commune. Visit to the Drainage and Irrigation System in Huancheng People's Commune.
October 9	Shunte County	Visit to Kanchutan Water Conservancy Project, which involves hydropower generation with low water head. Travel by train to Changsha, Hunan Province.
October 10	Shaoshan District	Tour of Chairman Mao's former residence and Exhibition Center.
October 11	Taoyuan County	Tour of Exhibition Center of Water Conservancy Construction in Taoyuan County. Briefing on the county's water development.

/Date

<u>Date</u>	<u>Place</u>	<u>Activities</u>
October 12	Taoyuan County	Visits to Yenchuan and Lilin Dams; Chungyang Dam in Chungyang People's Commune, where 3-kw hydro-generating units are made; Huangshih Reservoir and Chiuhsi Dam, under construction.
October 13	Taoyuan County	Visits to the Forest Farm of the Yutien People's Commune; the Chuangchiachiao and Hsinhochiao Production Brigades; Chiulang Reservoir and the March 8 Flume.
October 14	Changsha	Morning trip to Changsha and tour of the Han Tomb at Mawangtui. Discussions and briefing with local provincial authorities.
October 15	Changsha	Tour of the First Normal School of Hunan Province and of Chingshuitang, the former site of the Chinese Communist Party Hunan District Committee. Return trip to Peking, by plane.
October 16	Peking	Free morning. Tour of the Summer Palace. Dinner given by the Deputy Director of the Environmental Protection Leading Group, under the State Council.
October 17	Peking	Trip to the Fragrance Hill. Dinner for hosts given by the UNEP Mission.
October 18	Peking	Meeting with officials of the Planning Department, Ministry of Water Conservancy and Electric Power. Film show. Dinner given by the Director of Foreign Department, Ministry of Water Conservancy and Electric Power.
October 19	Peking	Departure for Japan and Mexico.

## II. GENERAL INFORMATION ON CHINA

### 1. General

Detailed information is available in published literature on the general social and economic situation of China.

This chapter of the report presents minimum general information to allow a brief description of the Chinese development, and which provides the necessary background for the mission account which will follow. The information included has been taken both from available literature and from the writer's first-hand experience during the study tour. It should not be considered, by any means, a comprehensive description of China but merely a necessary introductory note to the report, which will later on provide a partial basis for the conclusions and recommendations included in the last chapters.

### 2. Geographic Features

China is located in the Asian Continent, on the West Coast of the Pacific Ocean. It borders with Korea on the East; the Soviet Union and Mongolia on the North; Afghanistan, Pakistan, India, Nepal, Sikkim and Buthan on the West; and Burma, Laos and Vietnam on the South. (See figure 1.)

China's territorial extension is 9.6 million square kilometers. The distance between its borders exceeds 5 000 kilometers.

Administratively speaking, China consists of 3 municipalities (directly under authority of the central government), 22 provinces and 5 autonomous regions. Peking, Shanghai and Tientsin are the municipalities.<sup>1/</sup>

The Nation's capital is Peking, located on the northeastern edge of the country. It is China's political and cultural center. Shanghai is the main industrial center, and the most populous city, with over 10 000 000 inhabitants.

<sup>1/</sup> The Mission visited the municipalities of Peking and Shanghai; the Provinces of Honan, Kwangchow and Hunan, and several counties located in Shanshi, Hopei and Kiangsu Provinces.

China is a unified multinational country, with a present population of about 850 million inhabitants or nearly 89 persons per square kilometer; evidently the most populated country in the world.

The climate varies widely; some areas are warm throughout the year, while others have long winters and short summers; nevertheless most of the land lies within the temperate zone with four seasons. The temperature in the north and south varies greatly in winter and very little in summer, as a result of the monsoons.

### 3. Economic development planning

The People's Republic of China has completed the implementation of four successive five-year plans for social and economic development. The results of the last two plans have, in general terms, exceeded the proposed targets especially in the fields of agriculture and energy production. The general principle of "taking agriculture as the base and industry as the leading factor" has directed the over-all economic development plans. Hence in planning priorities are assigned to agriculture, as well as to light and heavy industry.

The general orientation and targets for China's development are spelled out by the National Communist Party Convention. The National Planning Commission then prepares the detailed five-year plans for the government to execute. Each ministry formulates detailed development plans, and assigns production quotas to the provinces; these, in turn, distribute the quotas among the counties and their subordinate communes.

However, there exists a bottom-to-top planning process since each people's commune, county and province does prepare partial independent plans for economic and social development, and for construction of civil, energy and water conservancy works. These plans are later on submitted to the higher authorities and are compatibilized with the national goals and plans. This interfingering of plans and its compatibilization make the Chinese method of planning a unique one.

Another interesting feature of the planning process is that the State is funneling more funds to those regions which have limited resources and have achieved less social and economic development levels. Then, too, the development plans include measures to ensure an industrial decentralization scheme, and to avoid large interchange of agricultural and energy outputs between, for instance, north and south thereby increasing provincial selfsufficiency.

#### 4. Industrial development

After 1949, China started building an independent integrated industrial system. This required the rapid development of the iron and steel industry, which already in 1973 resulted in a production of 23 million tons of steel and alloys. In addition, medium and small iron and steel enterprises were set up throughout the country, which allowed an improvement in industrial output distribution.

With regard to the machine-building industry, China has built a number of large modern factories and thousands of small to medium sized plants, and now produces tractors, motor vehicles, farm machinery, scientific instruments and equipment for the metallurgical, mining, chemical, petroleum and power industries.

The power-generation industry has also made important progress; a series of large and medium hydropower and thermopower stations have been built throughout the country together with about 60 000 small hydropower plants serving the countryside. The coal industry has developed likewise, especially in the southern provinces, therewith eliminating the need to transport coal from the north.

The chemical industry has also developed fairly rapidly in the past. There are at present many plants producing nitrogenous fertilizers, insecticides, medicines, concentrated nitric acid, caustic soda, and synthetic fibres. Light industry is another Chinese success of recent years; many cotton mills are scattered throughout the country while woolen mills are located in remote regions, together with paper, sugar, leather

and match factories. Other light industry products include synthetic fatty acids, detergents, wrist watches, sewing machines, cameras, bicycles, etc.

The petroleum industry has developed at an extraordinary pace. With the discovery of several oil fields and the establishment of a comprehensive petroleum industry system, China is self-sufficient since 1963 and now exports some oil.

Despite those achievements, China still lags behind the production levels of industrially developed countries. Long-term plans will allow China to produce the same total output (in volume) of oil, steel, coal and other goods, equal to those of the United States or the USSR, by the year 2000.

During the study tour, the mission was able to corroborate some of the progress achieved in the field of light industry, as well as the success of the industrial decentralization programme. In effect, every county visited by the Mission had the following small industries: steel foundry and mill, cement and chemical fertilizer plants, coal mines, farm implement factory. In addition to that, it was possible to verify the very important achievements in connection with industrial pollution control, as will be described later on in the report.

The quality of industrial goods produced in China appear to be comparable to that of those available in more developed countries, as could be verified during a mission tour of the Shanghai Industrial Exhibition Centre. There, samples were examined of many industrial products, such as rare metals for the electronic and war industries, more than 2 000 kinds of steel types, high temperature alloys, titanium products, ocean-going cargo and passenger vessels, 12 000-HP turbosuper-charged marine diesel engines, large-capacity dredges, ice-breaker ships, plastic and plexiglass engineering products, 32-ton dump trucks for mining work, 90-HP (Red Flag) limousines, agricultural tractors, 10-HP "walking tractors", combined harvester and planting machines, digital electronic computers, meteorological equipment, solar cells for energy production and many other products.

/It was learnt

It was learnt that in the main cities such as Shanghai, Tientsin, Kwanchow and Peking, medium and large industries have three 8-hour shifts. Each new development or design improvement comes from the "three-in-one groups" which are set up for that purpose, as well as from experiments conducted by the Academy of Sciences and other research institutes. The three-in-one groups consist of a technician --who is either a university trainee or an experienced worker--, a cadre and a worker. The group reportedly makes the necessary studies and modifications to improve the industry product. An ample program of worker rotation exists in the factories so that each person becomes familiar with the different phases of the work; new workers receive comprehensive in-service training by experienced fellow workers. Each factory has medical, restaurant and nursery facilities for the workers and their families.

The salary of the workers may amount up to 180 Yuans per month, according to experience, length of service and academic or technical training.

The State owns all the factories in the cities.<sup>2/</sup> It buys the products at a fixed price from one factory, and sells them to another factory which will need it as raw material, for a somewhat higher cost. The "profit" made by the State in this process is used to finance the national budget which includes the Army, the medical services, transportation, etc.

An interesting feature of China's industrial sector is the so-called "street factories", which exist in the main industrial cities. These organizations are set up with permission from the Street Revolutionary Committees, and under the sponsorship of a large factory. The street industry generally employs women --usually the wives of workers in the sponsoring factory-- in order to produce intermediate industrial goods (a maquila-type set up) which are sold at a predetermined price to the sponsoring factory to be used in their more-elaborate products.

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<sup>2/</sup> Those in the rural areas are owned by the County or by the communes.

Besides providing for full employment of the labor force, this scheme is a means of allowing each family to obtain a higher income through the wife's full time job and, in some cases, the "moonlighting" of the husband. Individual earnings are decided on the basis of personal output, as determined by the workers themselves through a daily quality-point survey, similar to the one employed in the agricultural sector.

One of the items which struck the minds of the mission members is the "walking tractor" produced in Shanghai and several county cities. It is a 10-horsepower tractor which performs the usual agricultural chores, and can even be used to power a small truck or a drainage pump. Each unit has a price of 2 000 Yuans. The mission visited a walking tractor factory in Hsinhui County, and was given a demonstration of the tractor's capabilities and performance.

#### 5. Agricultural development

China was a famine-stricken country in the past. Recent efforts have made the country self-sufficient in all but a few products, such as wheat which is still imported from Canada and other Western countries.

Since 1962, following the policy principles of "taking agriculture as the foundation and industry as the leading factor" and "taking grain as the key link and ensuring an all-around development", the Chinese people embarked on an agricultural development programme which has brought about more than 12 successive years of bumper harvests. Such effort required eliminating both flood threats in the southern provinces and droughts in the north. Activities such as reforestation, animal husbandry and fishery have kept pace with overall agricultural development.

After 1958, agricultural collectivization measures brought about the creation of People's communes, which integrate government administration with commune management. The commune system implies the ownership of the means of production at three levels --the commune, the

/production

production brigade and the production team-- each exercising its own administrative and accounting functions with the production team as the basic accounting unit. A people's commune can undertake farm capital construction on a large scale, engage in a diversified economy, carry out scientific experiments and guard against natural disasters, thereby ensuring the consolidation and the development of the collective economy.

Since China possesses vast water resources, the development of agriculture has been based in many water conservancy undertakings. These works include the construction of more than 2 000 large and medium-sized reservoirs to provide irrigation water, the building and reinforcement of hundreds of thousands of dykes, the digging of more than 100 large flood-diversion channels, the drilling of over a million water wells and the installation of power-driven irrigation and drainage pumps with more than 20 million horsepower capacity.

The previous works have enabled the harvesting of two and sometimes three crops of grain per year in the flatlands of the south and east, as well as the production of cash crops and other permanent and semi-permanent agricultural products. The usual flow pattern of agricultural product from south to north has virtually ceased to exist, and farm yields have increased more than seven times.

The increased output is the result of the application of the Eight-Point Charter for Agriculture, which includes: i) deep ploughing, improvement of quality, general survey and planned utilization of the soil; ii) rational application of fertilizers; iii) building of water conservancy works and rational use of water;<sup>3/</sup> iv) popularization of better strains of seeds; v) rational close planting; vi) plant protection, prevention and elimination of plant diseases and pests; vii) field management, and viii) improvement of farm tools.

Following the principle of "The fundamental way out for agriculture lies in mechanization", China has been carrying out a special way

<sup>3/</sup> From the principle of "irrigation is the lifeblood of agriculture".

of agricultural mechanization. All farm machinery is practically manufactured in each locality; the machines are usually of medium and small types, and their purchase is financed from the collective funds. Nevertheless, most of the work is still done through labor-intensive procedures.

There are outstanding examples of the Chinese struggle towards better agricultural production. The main ones are those of the Tachai Production Brigade and of the Red Flag Canal District. The first one is located in Shanshi Province, and has required terracing, irrigation and flood control works in order to produce about 9 000 kilograms per hectare, in previously barren mountain land; Tachai is presently the leading example of agricultural development in China. The Red Flag Canal --which will be described later on-- in Linshien County is another example of Chinese efforts wherein more than 50 times the initially cultivated land is now under full production, thanks to water conservancy works.

In contrast with past history, the people in the rural sector of China collectively own the land they work. Each commune is assigned a yearly production quota, which must be fulfilled and sold to the State at a fixed price. Should the commune exceed its quota, the excess profit may be kept for distribution among the commune members.

From the sale of the product, the commune pays the State an agricultural tax which amounts to 3-4% of the total earnings. Then, separate sums of money are set apart for capital investment (purchase of walking tractors, construction of water conservancy works, etc.) purposes, and for food, seed and chemical fertilizer acquisition. The remainder is then divided among the commune members according to their contribution to production. The individual production is established by means of a special accounting method. Each day, the production team members decide among themselves on the points earned by each individual, according to his efforts; at the end of the year, the points are added up, and income is pro-rated accordingly.

The mission was able to observe how both men and women, young or old, work hard in the agricultural fields. Since winter and spring months are inadequate --from the climatological point of view-- for intensive farming activities, the many million chinese peasants utilize that period for the construction of major civil and water conservancy works. Here again, the Mission verified that these works are carried out without the use of heavy machinery, utilizing instead the ample available labor. Since the peasants have already earned their income through agricultural production, no labor costs are assigned to each project constructed in this fashion, except when workers are assigned full time, during the whole construction period, to the project.

Each commune manufactures its own farm implements and tools; some even have small steel foundries and mills, as previously mentioned. "Barefoot doctors" are assigned full-time to each commune and production brigade.<sup>4/</sup>

The main fertilizer used is of organic nature --as will be described later on-- even though chemical fertilizers are gaining in popularity. The fields are well attended, in some cases earning the comparison to gardens, due to the ample availability of labor. Hilly areas are terraced and cultivated extensively. There are cases where peasants have brought tons of fertile soil from distant places in order to turn their lands into full production units.

The communes plan, design and construct their civil and water conservancy projects. The design and construction supervision is assigned to a three-in-one group similar to that used in the industrial sector.<sup>5/</sup>

<sup>4/</sup> "Barefoot doctors" are really paramedics trained to treat the most common diseases, and in addition perform duties as any other peasant in the field, a fact from which their name is derived.

<sup>5/</sup> When asked who makes the designs for the works, the reply was that they are made by the peasants themselves, a fact which is hard to believe until one learns of the tree-in-one group scheme. Then, too as in the case of the workers, the role of the intellectuals is downplayed and the credit is given to the peasants or workers.

The implementation plans are submitted to higher authorities for approval and for compatibilization within the provincial development plans. The cost of materials is borne almost entirely by the communes, from their appropriations for capital investment; the State only contributes the cost of specialized equipment. All equipment --whether for construction or for operation of the works-- are built at the commune's factories, unless they cannot be made locally and have to be acquired from county or province plants.

Following the same principle of self-sufficiency, the communes build individual energy production projects to satisfy their internal demands. Only when unable to supply their needs, do they tap the provincial or county electrical grids.

In addition to sharing the earnings produced by the land, each peasant family is allowed to cultivate a small piece of land (about one tenth of a hectare) where they can grow vegetables or whatever other crop they may wish in order to obtain a balanced diet.<sup>6/</sup> The more progressive communes are undertaking house renewal programmes, in which everyone participates; each peasant family finances the construction costs and owns the house. The Mission visited several peasant houses which usually consist of two rooms, used for sleeping, living and dining quarters, and a separate cooking room. Everything seemed very clean and orderly. One could usually see a bicycle, a radio, some fish bowls, and, in some cases, a sewing machine.

Pigs are very common in the rural areas, and their excreta is used for biogas production. Very few dogs could be seen in the farms, as they were nearly extinguished in the early sixties.<sup>7/</sup> Another item which interested the Mission members was the fact that despite the existence of many water reservoirs and fish ponds, no evidence of flies or malaria-producing mosquitoes could be found in the rural areas.<sup>8/</sup>

<sup>6/</sup> The Mission observed that, indeed, very few peasants sold for cash some of the goods produced in these private lots. We were told that these "capitalistic" activities were not encouraged by the people, that social pressure was strong against them, and that these activities were in the decline.

<sup>7/</sup> The same is also true of birds and cats. The explanation is that their presence diminished food availability for the human beings. The ecological impact of this action apparently has not been fully assessed.

<sup>8/</sup> Apparently, very effective extermination campaigns were carried out some years ago. Here again, the ecological implications are still not fully understood, but the results are truly astounding.

It was noted finally, that there are still marked differences among communes, since some of them are better off than others depending on the available resources and the degree of effort made by the peasants. It is understood that the central government is granting more aid to the less developed communes in order to achieve a balanced situation throughout the country.

#### 6. Rural energy development

China has vast energy resources, the quantification of which is not of public knowledge. However, the hydropower potential is estimated to be 583 000 megawatts, and present oil production is about 80 million tons per year. Hydroenergy production amounts to about 25% to 30% of the national energy capacity and production.

In connection with hydropower it should be mentioned that in the fifties and early sixties, emphasis was placed on the development of large dams and power plants. Small and medium size hydroprojects have developed rapidly in the last twenty years to meet the growing energy demands of isolated communes.

There are some large hydropower plants in operation, such as those at Mu-Chia and San-men (1000 megawatts each) and Hsin-an-Chiang (650 MW), which are built and operated either at the provincial or the State level, and whose output is used to supply city, industrial and agricultural energy demands.

In addition, presently there exist 60 000 small and medium size hydroplants with a 3 million-kilowatt total installed capacity, which supply an energy of about 25% to 35% of the agricultural demand of individual people's communes. Some 30 000 kW are installed per year through small hydroprojects in energy-hungry areas.

The mission learned --in regard to hydropower development and, more specifically, in connection with small-scale hydroprojects-- that the planning and construction of small hydropower plants (below 12 kilowatt installed capacity), is the responsibility of communes and even production

/brigades,

brigades, especially if these have had previous experience on this matter; however, their designs are approved and/or modified by county-level officials. The design of hydroplants with more than 100 000 kilowatt installed capacity falls within the State jurisdiction, even though the labor from communes will be used for their construction. For intermediate size hydroprojects the design and construction are carried out by counties or provinces, according to their capability and experience, but the approval of the design is always given by the next higher authorities.

For the design and construction supervision of small and medium projects, the three-in-one group system is always followed, except when special designs are referred to research institutes. These groups include a technician which normally has university or technical institute academic training, or a long experience in water development works. The above fact implies that the Chinese have trained a fairly large army of engineers and technicians which are scattered throughout the rural areas and which also do normal agricultural work.

The mission met with several such engineers and technicians in the fields, and was impressed with the results achieved with only minimal basic information. It was learnt for instance that a fairly large dam was built on the basis of only 14 years of incomplete hydrological records; and visited the site where the dam's spillway was being enlarged because last year's flood had exceeded the design capacity. More important, the works seem well done and there are no reports of dam failures due to improper design.

In addition to the use of small hydroplants, the utilization of methane biogas plants in the rural sector has proven to be a very good, pollution-free means of meeting isolated cooking and lighting energy demands. Besides providing energy, this method ensures a sanitary disposal of human and animal excreta and garbage and vegetal wastes, and provides a byproduct useful for agricultural fertilization, as will be discussed later on in this report.

7. Environment and development<sup>9/</sup>

China's environmental policies are formulated and implemented within the framework of their general development policies and planning. In the field of agriculture these policies reflect a response to China's excessive specialization and intensive utilization of her alluvial soils and river valleys and the resulting vulnerability to natural catastrophes. China's environmental policies have taken the form of land and water development schemes and large-scale afforestation projects; they include regional development and the decentralization of industries. These policies are also concerned with the improvement of public health through preventive medicine and the amelioration of working conditions both in rural and industrial areas. Chinese planners have paid increasing attention to the prevention of water and air pollution.

In contrast to Western approaches, Chinese policies are based upon an explicit recognition of some of the institutional causes of environmental disruption. In addition, there is a specific way of looking at 'waste' which supports the principle of a comprehensive use of resources with a view to "turning the harmful into the beneficial". Finally there exists a concern for man as the human factor of production in the sense of man as an end and not as a means. The policies aiming at the improvement of the quality of life through land and water conservancy and China's stress on agriculture as the foundation of economic development as well as her early emphasis on problems of community hygiene have been oriented toward, and centered around, the satisfaction of basic human needs. China's priorities and her general approach to development planning seem to give human life and human survival and the quality of life a value which does not always exist in other developing and even developed countries.

The implementation of this policy of environmental protection and improvement as a part of the economic plan of the People's Republic does not rely on capital intensive technologies but is being carried out

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<sup>9/</sup> This report section has been extracted and adapted from "Background Notes on China", prepared by E.E. El-Hinnawi, UNEP, 1976.

/by the

by the large-scale mobilization of human labour which in turn was greatly facilitated by far-reaching institutional reforms.

To some extent the transformation of the Chinese Earth mentioned above forms part of a policy of regional development. It aims at the creation of areas of stable yields protected against natural disasters and environmental disruption. This policy of regional development corresponds to an early socialist idea of reducing the difference between town and country. As a result of this policy it has been possible to avoid some of the high social cost of urbanization characteristics of the chaotic growth of many Western and Asian cities.

In the rural areas, two subjects are of particular importance with regard to the environment. First, China has succeeded in providing adequate and safe drinking water facilities, through an extensive water well construction programme. Second, it has drawn up health regulations for the utilization of sewage water for irrigation.

Several scientific institutes of industrial hygiene and occupational diseases were set up in central urban areas (e.g. in Tientsin, Shanghai, An-shan and Peking) in order to undertake the necessary research for the analysis of major industrial and occupational health risks and the elaboration of effective methods of preventing industrial hazards and of adequate labour standards, rules of inspection and enforcement and the training of the required personnel.

The selection of industrial sites within cities and the sites of the cities themselves is said to have taken place according to health requirements and principles of functional zoning. Thus, in new and expanding old cities, factories were built on sites opposite to the prevailing wind direction and were located down-river. Such prior planning was extended also to rural districts and to peasant Communes. Research conducted by the China Academy of Medical Sciences and the Peking Epidemiological Station led to proposals and the adoption of standards (in physical terms) for housing, indoor temperatures, ventilation, height limits in rooms which have served as guidelines for planning departments. The cities of Peking, Shanghai and Mukden are said to have relocated to the countryside all factories which were seriously contaminating the atmosphere.

## 8. Living conditions in China

The Mission was able to verify the fact that the Chinese people enjoy a secure life and are gradually raising the living standards.

### a) Employment

First, it should be pointed out that there seems to be full employment in the cities and in the rural areas of the estimated 500 million working-age population, which is presently growing at an estimated annual rate of 11 million. All graduates from colleges and secondary technical schools are assigned work by the State.

A great number of city women have been freed from household chores and employed in various fields of work, so that it is now very common to find several family members employed. This fact has resulted in a gradual increase of the average family income.

The government has reformed the wage system of the workers in order to take into account productivity and to reduce the wage gap.

Taxes are non-existent in the cities. In the rural areas, the State still collects a small percentage on tax for agricultural production based on the production quota; as pointed out earlier, no tax is paid on production which exceeds the established quotas.

### b) Medical and other welfare benefits

The urban Chinese people enjoy free medical treatment, labour insurance and other welfare benefits. The State takes care of childbirth, old age, sicknesses, injuries and disablements.

In the case of an ill worker, a sick leave with 40% to 100% pay is granted, according to the length of time in service. All medical expenses are paid by the State. During convalescence of an injury suffered while working, the workers receive full pay. A 56-day paid maternity leave is granted to women workers, and all hospital expenses are paid by the State.

/The pension

The pension of a retired worker amounts to 50% to 85% of the usual pay, the exact quantity depending on length of service record. Relatives of workers pay only half of the medical expenses when they fall ill; the other half is covered by the State.

The labor insurance expenses are paid in full by the State alone; no contribution is collected from the workers. For this purpose, the State assigns 17% of its total annual budget.

In the rural sector, each production brigade has cooperative medical facilities. Each family contributes a yearly sum of a few Yuans in order to participate in this scheme; no charge is made for treatment. Several brigades are now putting aside money, from their agricultural product sales, in order to subsidize the cooperative medical system and to reduce the family's direct contribution.

In the fields, barefoot doctors treat common diseases such as indigestion, diarrhea, colds, cough, etc. Anything more complicated is immediately referred to a commune clinic or, if needed, to a county hospital. These hospitals can perform minor surgery, caesarean child-birth, minor physiotherapy and take X-rays.

In an interview with a county hospital director, the Mission learnt that the main causes of death in the rural areas are old age, bronchitis, and heart disease. Cancer deaths allegedly are not very common, and such sickness is treated through surgery, radiotherapy and medicinal herbs, the latter being a successful Chinese tradition.

Birth control is encouraged by the State; an unwritten goal is two children per family. The State provides free birth control advice and all kinds of contraceptives. The result is a one percent annual population growth rate by 1975.

c) Prices and currency

The State has taken a series of measures to ensure a gradual rise in people's incomes, especially through controls in the prices of industrial and agricultural goods.

/The purchase

The purchase prices of the main agricultural products such as grain, oil-bearing crops, fibres and pigs are now twice as high as in 1950; on the other hand, the selling prices of chemical fertilizers, insecticides and diesel oil have been reduced by 30% to 70%. The price gap between industrial and agricultural products has thus been narrowed.

The prices of grain, cotton cloth, edible oil, cooking salt, coal, meat, vegetables and other daily necessities have remained stable and comparatively low for the past 20-odd years. There are of course minor seasonal fluctuations in the retail prices of fish, eggs and fruits, but they remain stable on the long-term average. The prices of medicines are very low and have steadily decreased in the past years.

Furthermore, the State has several times raised the prices paid to peasants for grain; it has maintained the selling price by financing the difference and by bearing the handling and transportation costs.<sup>10/</sup>

The Renminbi (or Yuan) is the national currency. Its value has remained stable for the past twenty-odd years, at 0.52 per U.S. Dollar. The reason for such stability is the absence of external debts, the nearly self-sufficiency in meeting internal needs, and a centralized control in the issuing of currency. The State governs the emission of currency and controls its absorption, so that circulation is kept under normal conditions.

#### d) Housing facilities

The picture of run-down slums and even using sampans to live in of the preliberation China is no longer valid.

Although there exist old --but clean and well maintained-- housing units in cities and rural areas, the State is making noticeable efforts to provide modern housing facilities to the city workers. These include high-rise apartment buildings, with ample living quarters and all necessary facilities. The State owns these and the workers pay 4-5%

<sup>10/</sup> As an example of this, the Evergreen People's Commune, located in the outskirts of Peking, sells rice to the State at 8 cents per kilogramme, which is later on sold in the city at less than 6 cents per kilogramme.

of their salary as rent, regardless of their income. Such rent includes water, electricity and garbage disposal services.

In the rural areas, the houses are owned by the peasants. The more prosperous communes are undertaking house construction programmes. The cost of such houses is borne by each family and all production team members help each other in the construction.

The Mission visited several of these dwellings and found them ample, clean and very tastely but modestly decorated.

e) Education

An education revolution has taken place in China during the past 27 years. Now-a-days more than 90% of school-age children regularly attend classes at the primary and secondary levels.

Besides higher education centres, and both primary and secondary schools, there exist numerous specialized institutes and high schools for city workers and many other educational institutions in the rural areas. As a result, illiteracy has nearly been wiped out.<sup>11/</sup>

Primary and secondary schools are compulsory and free of charge. Each high school graduate must devote three years to practical work after completion of his studies; there is a choice of going to work to an agricultural commune, a city factory or the Army.

After those three years, 60% of the youngsters may go to a university or any other higher education centre. The process for selecting those students which are to enter higher education levels is an interesting and unique one. During the period of obligatory practical work, the youngsters are organized in groups of five; each year, the five select among themselves the best qualified student that should go to the universities.

A university graduate usually requires about 13 or 14 years of non-continuous schooling for the fulfillment of academic requirements, and from one to three years of practical work.

<sup>11/</sup> The Mission verified this during both field and city tours. Some old timers and young children have learnt the new phonetic writing, and there is a national programme for adoption of the latin alphabet.

In addition to the former schooling, adults can make use of their spare time to attend special short courses - and even night school - in order to acquire general culture, learn special skills or study political theory.

The Mission was able to verify, during the study tour, the success of this educational scheme, especially when noticing the ample availability of technicians and engineers even at the production brigade level.

f) Other items of interest

The Chinese partially adopted the Bhuddist religion several centuries ago; the Confucionism phylosophy was widespread in the past. Now-a-days they have no religion of any kind; there is no other life after death, nor any cult to the forebears.

Personal cleanliness is a Chinese habit, which also applies to their living quarters; however, they do very little to enhance their physical features.<sup>12/</sup> They dress very much alike when going to work, but show some individualism characteristics in their dressing at home.

The difference between sexes is very much downplayed. Women and men have equal rights and duties; examples of this will be mentioned later on in this report. They marry only after reaching 25 years of age, in a very simple family affair. The last name of the children can be that of either parent, as the couple may choose; however, the majority adopts that of the father.

The food is plentiful and excellent, consisting of a variety of products which include meat, poultry, eggs, fish, vegetables and fruit.

China has a very long history of natural disaster recurrence which includes floods, droughts, earthquakes, typhoons, etc. Due to the government determination to guard the people against all calamities, many interesting developments have taken place in this field. Original and ingenious as well as conventional methods for prediction of disasters causing natural phenomena, are commonly used. Very efficient warning

12/ For instance, women wear very little if any make-up.

and evacuation procedures have been devised and put into use. Finally, disaster relief organization and implementation is of top quality. The above was evident during and after several recent earthquakes which hit densely populated areas.<sup>13/</sup>

In general, the author believes that the Chinese are a very happy, hard working, well fed and healthy people.

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<sup>13/</sup> Although not widely published in the Western Hemisphere, the Chinese have recently predicted the forthcoming occurrence of another major earthquake, possibly during winter time in 1977.

### III. DETAILED ACCOUNT OF MISSION HIGHLIGHTS

The following are detailed accounts of several schemes visited by the Mission, which - in the writer's opinion - are the most outstanding aspects observed during the tour.

#### 1. Linhsien County and Red Flag Canal

This county is located in the Taihang Mountains of Honan Province, and is a model of water conservancy and development work.

From 1960 to 1972, the peasants made an impressive effort in order to build what is now called the Red Flag Canal. This scheme involved construction of 200 small to medium size reservoirs, 40 hydropower stations, 154 drainage and irrigation electric pumping plants, and some 1 500 kilometers of main and branch canals. Water is diverted from the Changho River, many miles away, through a canal winding round some 1 000 hilltops, crossing 1 900 gullies and passing through 134 tunnels.

The project was executed by means of intensive use of available labor, especially during the winter and spring seasons, when agricultural work is at a minimum level.

Before the project was constructed, it was possible to irrigate only 800 hectares of land; now, 40 000 hectares are under irrigation. During the year, two crops of rice and one of wheat are produced. The aggregated agricultural yield exceeds 4 800 kg/ha.

Before the project, the county was unable to supply its own grain needs; the State used to provide 9 million kilogrammes per year. Now, after providing for its own needs, the County has a surplus of over 24 million kilogrammes which is sold to the State.

The actual reported project costs was some 47 million Yuans for the main water conveyance system and 20 million more for the distribution works.

The Mission visited the trunk and branch canals of the system; the Youth Tunnel (built only by youngsters); Nankutung Reservoir and dam for irrigation diversion, flood control and fish breeding,<sup>1/</sup> where the spillway is being expanded to accumulate a 5 100 m<sup>3</sup>/s flood; the Heroes Canal and its small hydropower stations, and a scheme of 23 small hydropower plants located along an 8-km long canal with a total installed capacity of 1 085 kW, the smallest unit being of 40 kW capacity and generating at 400 volts. The Mission also visited the Dawn Aqueduct which is 550 meters long, has a maximum height of 60 meters, and required 6 000 cubic meters of masonry work; it was built in 60 days utilizing a total of 360 000 man-days, and its cost (exclusive of labor) was 380 000 Yuans.

The Mission visited the Dawn Tunnel and Pumping Station. Twenty-one production brigades dug the 4-kilometer long tunnel, employing 110 300 man-days;<sup>2/</sup> it required some 40 000 cubic meters of earth, rock and masonry work. The pumps deliver 140 cubic meters of water per hour to a reservoir located 70 meters above the tunnel level, and allow irrigation of 2 700 hectares of farm land.

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<sup>1/</sup> This is a rock-fill dam with an imperious clay layer, which required 3.76 million man-days of work. 1.8 million fish (carp) were recently planted. The dam was designed by a technician recently graduated from a 3-year college course on hydraulics and water conservancy, on the basis of 15 years of hydrological records. Due to an extraordinary flood which occurred last year, the spillway design capacity had to be increased by about 45%.

<sup>2/</sup> Here the Mission noted how the Chinese construction methods differ greatly in conception from those of Western countries. In order to speed up the completion of the tunnel, 36 vertical shafts were dug so that 72 construction faces could be made available to make use of an ample labor force, instead of the usual two.

## 2. Biogas generating schemes

The Mission was able to examine in detail several biogas plants which produced up to 60 cubic meters of methane gas per day, to supply the energy required for cooking and lighting for up to 20 persons.

The plants consist of a bell-shaped fermentation chamber, buried in the ground, which is fed with human excreta (20%) pig manure and vegetable waste (30%), and water (50%). This basic input fermentates in the chamber, which process is aided by means of a manual stirrer operated for several minutes, three times a day. From the top of the bell chamber, a plastic tube delivers methane gas to the nearby kitchen, supplying enough fuel to four cooking units and one light bulb. On the other side of the fermentation chamber, there exists a covered outlet which enables extraction of residues to be used as agricultural fertilizer.

The input for these biogas units is the daily excreta of about 20 persons, the manure of two or more pigs, garbage and maize leftovers. The main product enables cooking for such a small community; the by-product is a highly concentrated organic fertilizer which is extracted as required.

The small plants are built by the interested production teams and are cleaned once a year. No odor issues from the units and all waste materials are put to good use. The users also design and build small rudimentary indicators of gas availability, end nozzles and burners for the kitchen as well as other small appliances for the system.

The applicability of this low-cost pollution-free energy production scheme seems evident for many other developing countries. The Mission visited several biogas units, with various refinements, in different countries and people's communes; no actual labor and material costs could be ascertained, however, but these should indeed be very low.

### 3. The Yellow River and Mangshan Pumping Station

The Yellow River is China's second largest. It flows through eight provinces and has a 5 400-kilometer length; its catchment area is about 752 000 square kilometers.

The river carries 1 600 million tons of silt per year, of which 25% is deposited along its banks. The silver bed near Chengchow has been rising steadily, so that at the present time it is 3 to 5 meters higher than adjacent lands.

During the past 2 500 years, the Yellow River has breached its levees nearly 1 500 times, and changed course 26 times. In 1953, 10 million people began work to harness the river; they constructed large flood control and hydropower generation dams and works, plus many small and medium hydroprojects.

The river is 5 km wide near the Nanking bridge. Its average flow is 1 500 cubic meters per second, which may reach up to 22 000 during rainy seasons; it is about 3 or 5 meters deep at the present, and may be as much as 10 meters deep in the summer season. The total installed capacity in the river is 11 000 Megawatts.

The Mangshan Pumping Station - visited by the Mission- took 27 months to build. 10 cubic meters per second<sup>3/</sup> of Yellow River water are pumped to a height of about 83 meters; 60% of the flow is delivered to Changchow to supply potable water needs and the remaining 4 cumecs are used to irrigate 6 000 hectares of farmland.

The main problems involved here refer to silting and the hardness of the water. The average silt content of the pumped water is 37 kg/m<sup>3</sup>, and may reach 200 kg/m<sup>3</sup> during the flood season. The pumped water is allowed to settle, in silting basins downstream of the pumping stations; the removed silt is used to fill nearby gullies and land depressions. The problem of turbine wear due to friction by silt-laden water is solved through porcelain coating and replacement of the impellers twice a year.

3/ Hereinafter termed cumecs for brevity.

It was noticed that an additional 24-cumec capacity pumping plant is under construction, to increase the irrigated farmland.

#### 4. Industrial pollution control in Shanghai factories

A factory which produces copper enamel wire was visited. In the late fifties and early sixties, this industry was faced with the problems of air pollution and high energy requirements. In 1972, after studies and designs were made by a "three-in-one working group", a catalytic combustion device was installed. It allowed the recycling of 95% of the exhaust gas, the savings of 60% of energy input, and a noticeable increase in the product's quality. A multi-layered catalytic device is in the process of installation, which should bring about much better results.

The Mission also visited a carbon electrode factory, located in the outskirts of Shanghai. It manufactures graphite electrodes for the production of high-temperature archs in the metallurgical and chemical industries. Since the production process involves the addition of chloride and fluoride gases, harmful gases are released which pollute the environment, create a health hazard and damage nearby cropfields.

In 1972, a pneumatic-pulse, bag-type dust removal unit was installed; it enabled the collection and reutilization of 99% of the carbon dust which amounts to some 1 000 tons of material per year. Also installed were recovery towers, which allow 90% of the harmful gases to be recovered (200 tons of hydrochloric acid are now recovered per year), and electrostatic dust precipitation which enable a 90% clean smoke and the collection of 300 to 400 kilogrammes of tar per year. The Mission was able to observe the difference in exhaust smoke when the air-pollution control devices were disconnected. In spite of the results achieved, the factory members are determined to design and construct pollution control devices that will achieve 98% efficiency.

The Mission was impressed with these achievements, especially considering that the Chinese have used their own ingenuity without relying upon imported techniques. It should be noted that in Shanghai, the main industrial center, the level of air pollution was indeed very low.<sup>4/</sup>

#### 5. Liuhsi River irrigation and hydropower development

The Liuhsi River basin is located in Kwanchow Province, and has a total areal extent of 2 300 square kilometers. It includes two counties and 18 people's communes. The main river stem is 156 kilometers long, and has a total head of 214 meters; the estimated hydroelectric potential is 80 000 kW. The basin is inhabited by 740 000 people, and has 44 700 hectares of farm lands, 80% of which is paddy fields.

Since an annual average rainfall of 1 900 millimeters takes place chiefly during the period April-September, flash floods and prolonged droughts are common in the basin. A comprehensive river development scheme has been designed and put into practice through stages. This work required the construction of the large upstream Liuhsiho dam for power generation, flood control and irrigation; the building of levees along river banks in the lower reaches of the river; the construction of 490 reservoirs with a total storage capacity of 560 million cubic meters; the installation of hydropower generating plants with a 54 800 kW total capacity; and the construction of irrigation systems to cover a total area of 34 700 hectares.

Of the 64 800 kW total hydropower installed capacity, 42 000 kW (65% of the total) belong to a single project run by the Province, 8 800 kW (14%) refer to a project owned by the Municipality of Kwanchow, and the remaining 14 000 kW (21%) are run by people's communes through small, independent hydroprojects. The Mission visited several projects, both large and small, either run by the Province or by the independent communes.

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<sup>4/</sup> In Mexico City, which is about the same size and with significantly less industrial development, the level of air pollution is much higher. However, in Shanghai the pollution from internal combustion vehicles is almost nil due to the use of bicycles.

In Tsunghua County, a visit was paid to Liuhsiho dam and power station. This is a concrete, double-arch, 78-meter high dam with a storage capacity of 325 million cubic meters (MCM); with the recent addition of inflatable rubber gates, its storage capacity was increased to 355 MCM, or 63% of the total basin storage. Its hydropower installed capacity is 42 000 kW or 65% of the basin available hydropower; the plant produces 155 million kWh per year, which are delivered to the provincial grid. The dam was built by a human force of 25 000 during a 27-month period; its cost, exclusive of labor, was 38 million Yuans.

The Liuhsiho dam allows control of floods and irrigation of 26 700 hectares of farm land, using the tail waters from the power station. The latter was designed by the Shanghai-Kwanchow Institute; the generators were built in North-east China; the operation and maintenance is made by the Kwanchow Province.

The Mission also visited Liangku People's Commune, in Tsunghua County, where 53 small hydropower stations have been built with an installed capacity of 3 200 kW. Of the 53 units, 8 are synchronized to the County grid, and 41 are run independently by the Commune to satisfy the energy demands of its production brigades. The latter avoid the use of long and expensive transmission lines, and generate at low voltage (400 v).

In the Liangku Commune, which has 5 384 families and about 25 000 people, there exist about 1 700 hectares of arable land - of which 1 500 are paddy fields - and 31 000 mus of forests. The hydropower plants are located in cascade along mountain streams and rivers; there is even a small 15-kW hydrounit which is used to provide energy for a paper mill. All civil works and non-specialized equipment are built by the people themselves. The total investment - again exclusive of labor costs - for the 53 stations was 2 million Yuans, and the State only contributed 80 000 Yuans in the form of specialized equipment.

Man-made Lake and Dam are located in the Liuhsi river main stem, in Tsunghua County. They are used mainly for power generation and river crossing. The power house has an installed capacity of 1 250 kW, and includes 5 generators of 250 kW each. The turbines of these are made of reinforced concrete, and have been in operation for the past three years. This is a unique feature for such type of installation - which clearly demonstrates the Chinese principle of self-reliance - and should be closely followed in the future, in order to determine its performance and possible application in other developing countries.<sup>5/</sup>

The Mission visited Huatung People's Commune in Huasien County. It has 20 production brigades and 31 production teams, with a total population of 63 000 persons; 4 700 hectares of irrigated farmlands most of them paddy fields, and several small size industries. The people have built 26 small reservoirs and two dams on the Liuhsi river, together with 26 kilometers of main irrigation canals. All families have electric lighting, and electric power is used for the processing of agricultural products. Individual visits were paid to an iron foundry and mill, a farm implements factory, and several agricultural products processing units (peanut oil and rice mills), as well as the agricultural experimental station and the hospital.

The Huatung Commune is a very prosperous one. They have an agricultural output of 8 200 kg/ha of grain (three crops per year) and sell 11 million kilogrammes of grain to the State. The average family income is 584 Yuans per year. It has 32 schools, 3 high schools, with a student enrolment of 13 000; one hospital and clinics for the production brigades, manned by 110 barefoot doctors.<sup>6/</sup> All these accomplishments required only minor aid from the State since the commune is really self-sufficient.

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<sup>5/</sup> The plant was originally designed by Russian advisors and was intended to operate with Russian-made generators. Since the design and construction of the concrete turbine required development of new techniques by the Kwanchow technicians, the plant was renamed the "Anti-revisionism Power Station". The cost of an equivalent steel turbine is estimated at 80 000 Yuans its weight and 8 tons and its useful life at 15-20 years; the reinforced-cement turbine cost was 30 000 Yuans, the weight is 5 tons and no useful life estimates are available as yet.

<sup>6/</sup> Available information on this commune indicates they have 374 small agricultural tractors and that 65% of the land is mechanized. 13 000 new houses have been built in the past 10 years, 16 000 bicycles and 8 000 sewing machines have been bought. The commune has savings of 2.8 million Yuans. Every person pays 2 to 3 Yuans per year for the medical cooperative system, and there is no additional charge for any treatment. The commune intends to subsidize this system in order to lower the per capita cost.

## 6. Cascade hydropower development in the Kutou Mountains

A detailed study was made of the Kutou Mountains small hydropower development scheme, located in Hsinhui County, Kwanchow Province.

Hsinhui County occupies an area of 1 700 square kilometers in the Pearl River delta. The population is roughly 700 000, and the available farmland amounts to 53 000 hectares. It is located in a typhoon-stricken area, which also suffers from prolonged periods of drought. However, after completion of water conservancy works, two rice crops per year are produced with a total output of more than 7 500 kg/ha and to sell a surplus of 100 million kilograms of commercial grain to the State.

Industry has developed very rapidly since 1949. It includes small to medium size factories, a chemical fertilizer and a cement plant, and a shipyard. The Mission visited a walking-tractor factory which turns out an average of 24 units per day.

The county is undertaking a program of land reclamation from the sea with a goal of 5 300 hectares by 1980; up to now, 140 hectares have been reclaimed and placed into cultivation.

In regard to water development, the people of Hsinhui county have built or reimproved 650 kilometers of dikes along the main rivers, 256 small multipurpose mountain reservoirs with 200 MCM storage capacity, and 46 small hydropower stations with a 10 000 kW total installed capacity.

In spite of the above, and of the fact that several more hydro-projects are under construction,<sup>7/</sup> the county still depends upon the provincial power grid to obtain nearly 60% of the energy required. Nevertheless, the communes are in the process of building more small hydroprojects in order to achieve energy self sufficiency.

<sup>7/</sup> Which will add 10 000 kW more by 1980.

The Kutou Mountains hydropower generation scheme - which the Mission visited extensively - required a total of 6.3 million man-days to build. It involves six different stages with varying capacity generators, ranging from 125 to 1 000 kW. It also includes a small 100 kW capacity unit which is still in operation but was originally intended for supplying the power required for the construction of the works.

The Mission toured the Huanchang People's Commune irrigation and drainage system which covers 800 hectares of farmland. It is a project which is still under reconstruction in order to improve the old irrigation and drainage canals. The scheme involved reinforcing and lining of the main canals, and the reclamation of 35 hectares of land from the seashore.

The Kanchutan Water Conservancy project refers to a (0.6-1.4 meter) low head hydrostation with an installed capacity of 5 000 kW, which includes 10 generating sets of 200 kW capacity and 12 additional units of 250 kW each. This is low dam with a lock canal on the side to allow for small to medium-size boat navigation. The total dam and lock investment was 9.75 million Yuans, including 3.15 million in labor costs. It was all financed by the communes involved. The State contributed with only 100 000 Yuans for the cost of designing and testing of the turbines. The dam was originally intended for improving river navigation only, but nowadays generates 12 million kilowatt-hours per year and controls floods in an area of 17 000 hectares of low-lying lands. The generating units are synchronized to the provincial grid, and supplies about 60% of the area's energy demands.

### 7. Shaoshan irrigation district

The Shaoshan irrigation district includes the birthplace of the late Chairman Mao, in Hunan Province.

The water conservancy and energy works constructed provide water to irrigate a total of 61 000 hectares, 54 000 of which are paddy fields; 13 000 kW of hydropower plant capacity; navigation of boats with up to 20 ton capacity, and drainage facilities for 10 000 hectares of water-logged lands. In order to construct these works, a 100 000 man force was utilized; they mobilized 38 million cubic meters of earth and rocks in a period of 40 months. The system includes 2 500 kilometers of irrigation canals, 101 reservoirs, 52 900 ponds and 3 900 dams, as well as 26 tunnels (6 kilometers long), and, finally, 155 kilometers of drainage canals.

### 8. Taoyuan County hydropower and forest development

Taoyuan County in Hunan Province covers an area of approximately 4 800 square kilometers, of which 102 000 hectares are farmland and 300 000 hectares are hilly lands. The county includes 9 districts, 2 towns, 60 people's communes and one farm.

The 860 000 inhabitants have built by themselves a total of 127 small hydropower stations with an installed capacity of 12 546 kilowatts; 4 300 kilometers of trunk canals for irrigation, and many reservoirs with a combined storage capacity of 980 million cubic meters. From the total hydropower capacity, 65% belong to plants located below reservoirs and 35% (2 849 kW) to run-off-the-river plants.

All communes and 50% of the production brigades have electric lighting in the house, and there exist some 5 000 biogas generating units used for cooking.

Only a 6 000 kW hydroplant is connected to the grid; the remaining stations operate independently in isolated areas.

The Mission visited Yenchuan Dam and Power Station, where 100 000 people worked during a 60-day period to build a large capacity canal and the dam.<sup>8/</sup>

<sup>8/</sup> The channel is 15 kilometers long, 195 meters wide and has 12-m high levees as well as a 3 800 cumecs maximum discharge capacity.

It includes 4 hydro-turbine generating sets of 125 kW capacity each, with a low head; and navigation locks for boats of up to 20 ton capacity. The highway bridge, on top of the dam is 203 meters long, 6 meters wide and has a load capacity of up to 60 tons. The total project cost, exclusive of manpower, is 2.5 million Yuans; the State provided 915 000 Yuans, the county 1.6 millions and the remainder was provided by the communers.

Lilin dam was built in 1971; it is 200 meters long, 6.2 meters high, and made out of masonry. It houses a turbine-pump and generating units which provide 500 kW with only a 4-meter head.

Chungyang People's Commune dam and power station was also toured by the Mission. It houses 11 hydroturbine/pumping station units, with a present installed capacity of 375 kW. The dam has a navigation lock, 25 meters long and 9 meters wide and also provides water for irrigation of 7 300 hectares of farmland. The total investment required was 932 000 Yuans, of which 70% came from the commune.

This commune has small and medium size farm implement and miscellaneous equipment factories. The Mission inspected a water turbine generating set of 3 kilowatt capacity, which was designed and built by the local workers. The unit was being tested at the time of the Mission's visit,<sup>9/</sup> and can certainly supply the energy needs of a small community.

Huangshih (Yellowstone) dam and reservoir are the largest in the county; they provide for hydrogeneration, irrigation and flood control. The total reservoir capacity is 440 MCM and allows for irrigating 28 000 hectares of farmland. It has a 6 000 kW hydroplant installed capacity, which is synchronized to the county grid. The construction of this large project required a total of 34.7 million man-days, with a peak labor demand of 50 000 persons; it required moving 31.8 million cubic meters of earth and rocks. The total investment, excluding labor costs, amounts to 44 million Yuans; the State provided 17.6 million, while the interested communes put up 26.4 million.

<sup>9/</sup> This "baby" unit operates with a 69 liters per second water flow, requires an 8 meter head, and rotates at 1 450 RPM. It generates exactly 3 kilowatts at 380 volts. The complete set which includes the turbine generator and the electrical control device, weighs 95 kilogrammes and sells for 800 Yuans.

The Mission visited Chiuhsi dam, which is under construction by means of labor-intensive methods, and was able to observe in minute detail the construction techniques. The dam is of the floating-type, 90 meters long and 6.5 meters high, with a 25 meter long and 9 meter wide navigation lock. Although the chief objective is irrigation, the dam will also provide water and facilities for other purposes as well. It will irrigate 400 hectares of farmland, and will include a 3-unit 750 kW hydroplant.

The construction of Chiuhsi dam requires the continuous labor of 500 skilled people, and that of 4 000 unskilled workers during 4 months in winter and spring. Only 3 technical supervisors, including the designer-technician, are on site. No mechanical device of any kind is used; only human labor. The dam and auxiliary works will be completed by February 1977. The dam cost is 620 000 Yuans.

A 55-hectare subterranean irrigation and drainage system was visited in Hsinhochiao Production Brigade. The main ditches are buried and function by gravity force alone. The material for the subterranean ducts is a (1:9 by volume) mixture of lime and clay. It is almost a maintenance-free system, which requires only silt removal from stilling wells. The system allows significant water savings as both evaporation and seepage losses are minimal. The agricultural yield here has reached 15 000 kg/ha per year, from three crops.

The Yutien People's Commune has a population of 13 000 persons; it has 1 300 hectares of farmland and 2 400 hectares of mountain areas. The previously-barren mountains have been planted with timber forests (1 300 ha), high production forests (370 ha), and tea and fruit trees (230 ha). The timber output at the present is about fifteen cubic meters per hectare per year, which is sold entirely to the county as raw product and result in a total annual income of 180 000 Yuans. Small factories produce a net additional income of one million Yuans per year. The total cash income per capita for this commune, after food and basic expenses have been met, is then about 90 Yuans per year. The Mission visited the already-grown forests, and the recently planted areas including 6 hectares of forests which were planted by the women of the commune alone on 8 March 1974.

The Mission also visited Chuangshiaochiao Production Brigade which has 1 560 inhabitants and owns 165 hectares of farmland. The fields are extremely well attended and produce two crops of rice and a third crop of wheat per year. The average yield in the brigade is 12 000 kg/ha, but a very old farmer has exceeded 25 000 kg/ha per year, twice in a row. In this brigade, a 170-day variety wheat is utilized, as well as 60 and 100-day rice varieties. In the way of fertilizer, 37 500 kg/ha of "green manure"<sup>10/</sup> is added to the soil each year, together with 1 650 kg/ha of phosphate and nitrogen chemical products, and 7 500 kg/ha of pig manure and agricultural wastes.<sup>11/</sup>

Chiulong (Nine Dragon) Reservoir is formed by an earthdam, 25 meters high, and has a storage capacity of 13.5 MCM. It provides irrigation water for 1 450 hectares of farmland, and presently allows hydropower generation through two units with a total capacity of 193 kilowatts. The energy demands for agricultural products processing and irrigation pumping have been met, and the grain output has reached 7 500 kg/ha per year. 6 313 families are fed from this agricultural output and about 50% of the people have electricity; with the addition of another 200 kW hydrounit, the total population will have electric power.<sup>12/</sup> In 1975, the commune utilized 1 020 000 kilowatt-hours of electricity, 72% of which was produced at the Nine-Dragon power house.

The Mission briefly visited the 8 March Aqueduct which was reportedly built by women alone. It is designed for a 500 liters per second water discharge; the structure is 176 meters in length, 7.5 meters high, and was built of masonry by 100 women, who worked at the site for 3 months. A stone quarry was also visited; there, 78 high-school graduate women are hand-cutting stone blocks, which weigh about 50 kilogrammes, similar to the ones used in the aqueduct. It is a full-time job.

<sup>10/</sup> This is a special plant grown in the field, which is later on buried in the soil as natural fertilizer.

<sup>11/</sup> In spite of all the fertilizers added, one can only wonder whether long-term farming at such production levels will not eventually result in a lack of trace elements.

<sup>12/</sup> The power house has two generating sets which utilize the same 16-meter head. One is a 68 kW european-made unit which utilizes 350 liters per second of water; the second one is chinese-made, has a 125-kW capacity and requires a flow of 920 liters per second. There is a noticeable lower efficiency in the chinese unit as compared with the european generator.

#### IV. SUMMARY OF CONCLUSIONS

This chapter summarizes the findings and conclusions of the writer in connection with the energy and environment UNEP mission and offers some general impressions on the general social and economic development of China.

##### 1. On the energy and environment subject

The Chinese people appear to be advancing towards a state of self-sufficiency in energy production in the rural areas. Such demand is being met through the construction of small to medium size hydropower projects and the utilization of biogas methane-generating units, with a progressively less dependency on the provincial electrical grids.

In regard to the hydropower plants, the small projects are designed and constructed by individual communes and even production brigades, while the medium-size schemes fall within the jurisdiction of counties or provinces.

The small hydroschemes have a capacity ranging from 3 to about 250 kilowatts; are usually built in cascade along the same streams or rivers, and are generally operated independently and at low voltage to satisfy the needs of the communes. These plants are usually intended to supply domestic and agricultural pumping and product processing electricity demands, and generally have short transmission lines and distribution networks. They are operated and maintained by the interested communes.

The medium size projects are generally of the run-off-the-river type, operated in conjunction with irrigation diversion and river navigation facilities. Their capacity ranges up to 6 000 kilowatts and is based on low-head schemes; their output usually goes to a county or provincial grid system.

The biogas methane-producing units are used extensively in isolated villages, to supply the cooking and lighting demands of one to four family dwellings. They also provide means for disposal and utilization of human

/and animal

and animal excreta, garbage and vegetable waste; at the same time, they produce an excellent byproduct for agricultural fertilization.

Both the hydropower and biogas energy-producing units are pollution free, and provide excellent and economical means for each rural commune to become self-sufficient. In addition, the hydro-projects provide facilities for flood control, river navigation and fish-breeding purposes which are also of importance to human life.

It should be noted, however, that energy production in the rural areas of China is mainly directed to supply the domestic (lighting and cooking) and agricultural (pumping and product processing) demands, instead of the usual western case of providing for industrial needs.

It is the belief of the writer that the Chinese experience in regard to small-scale development of pollution-free energy sources can successfully be transferred to the particular conditions of other developing countries, especially to those areas which are presently under reclamation and settlement.

These regions - at least in the countries under the jurisdiction of the ECLA Mexico Office - are usually located far away from existing electrical energy transmission lines, and have ample water and other energy sources. Thus, the development of energy projects, following the Chinese experience, would prove both practical and economical since the settlers would utilize the resources to which they have immediate access, the countries would avoid high expenditures in the construction of expensive electric transmission and distribution networks, and the present negative impact on the environment - brought about by the cutting and burning of woods for cooking, heating and lighting purposes - would be curtailed.

Then too, the settlers usually have the necessary organization and drive to undertake such works. It is only the technical know-how and specialized equipment that would have to be provided by each government in order to ensure the project's success.

In addition to the social development cases mentioned above, the writer believes that - with the ever-increasing high prices of oil - it would be worthwhile to make a detailed study on the economic feasibility

/of constructing

of constructing small and medium-sized hydroprojects connected to the national grids in selected Western countries. These were abandoned in the past in favor of large-capacity (50 000 kw or more) hydroprojects, because the smaller ones were found uneconomical when compared to equivalent, alternative oil-fired units, and because it was easier to operate a few larger units than many small plants.

## 2. On the general conditions in China

The Chinese system of socialist development - although not yet reaching the final stages of ideal socialism - has proven quite successful in improving the living conditions of the inhabitants of China. Through more than 25 years of impressive effort, the Chinese people, guided by its leaders, have succeeded in creating a society wherein all basic necessities of life appear to have been met.

The social and economic planning process has succeeded in regulating overall development in the whole country. The planning process includes both the centralized orientation at the top, and a planning of specific development process by lower administrative levels. There exists therefore a two-way planning process which involves a necessary compatibilization, which could be of special interest to Western planners. The successful implementation of several five-year development plans, has brought about a decentralization of the economy and a progressive equalization of regional development.

The industrial sector has developed rapidly in the past two decades. A decentralization programme for these activities has been successful, since all rural areas have at least the basic industrial factories required for their independent economic and social development. Of particular interest is the existence of small basic factories at the commune level to produce farm implements and home appliances.

In agriculture China has succeeded in undertaking a "green revolution", through the implementation of water conservancy schemes, the introduction of high-yield grain varieties, and the rational use of soils, fertilizers and pesticides. The basic agricultural organization for production

/and the utilization

and the utilization of organic fertilizers to sustain continuous high-yield production should deserve special attention by Western officials.

There is no apparent energy crisis in China. The constantly growing energy demand for agriculture, domestic and industrial purposes is met through development of oil, hydropower and biogas resources. The large concentrated demands of urban and rural areas are met through large electric production and distribution schemes. The small-scale demands in isolated rural communes are met through implementation of small to medium size hydropower and biogas systems, constructed directly by the interested communes.

The construction of all - major or small - civil and water conservancy works is done by labor-intensive methods, employing the millions of people which are almost idle during Winter and Spring months when agricultural activities are at a minimum.

The Chinese people appear to enjoy a situation of full employment with increasing salaries, decreasing costs of living and stable currency conditions. Their educational, health and housing systems seem to be more than adequate, and are being improved. China has also succeeded in voluntarily controlling the demographic expansion rate.

The existing methods for the prediction and prevention of natural disasters, as well as the organization for relief after these calamities, are one of the best in the world.

Then too, China has enacted environmental policies which are included in her national development policies and plans. Since the Chinese consider men as the main factor for production, every effort has been made to provide a healthy environment both in the urban and rural areas. In sum, the Chinese have succeeded in making development and environment conservation go together.

## V. RECOMMENDATIONS

From the foregoing descriptions of the writer's conclusions derived from the study tour of China, some recommendations can be formulated.

### 1. On the energy and environment field

In order to justify the application of the Chinese experience in Western developing countries, an effort should be made to apply Western economics and financial accounting methods to the Chinese small-scale energy development schemes. A mission by international lending organizations officials, including representatives from regional and subregional development banks, may be the most adequate way for this study.

Developing countries should review the technical convenience and economic analysis of undertaking the construction of small hydropower projects to supply the energy needs of isolated villages, a scheme which has been abandoned in Western countries in favor of constructing ever-growing long transmission lines from the national power grids.

Likewise, a study should be made of the economic feasibility of constructing - and synchronizing with the national power grids - low-head hydropower generation schemes, established in combination with irrigation-diversion and river navigation facilities.

Further investigations should be carried out in the developing countries, to determine the technical and economic feasibility of developing solar, wind and other non-conventional energy sources. In this respect, two undertakings are in order for the Central American Isthmus countries. First, a reconnaissance-level study of solar radiation, wind velocity and direction, and tide variations should be initiated. Second, demonstration schemes of biogas and small hydropower developments should be set up and, when the information becomes available, practical experiments in connection with the harnessing of solar, wind and other energy sources should be undertaken. The UNEP should take a leading stance on this, with the collaboration of the ECLA Mexico Office.

/At the same

At the same time, the UNEP should organize follow-up study tours of China on the small-scale energy and environment field. Such missions should include representatives of the organizations in charge of the execution of electricity and agricultural development projects.

In connection with further cooperation between the UNEP and the People's Republic of China on the environment field, other sectors of the economy should be examined in detail. The choice of the industrial sector for the next mission would seem to be an appropriate one.

## 2. On the general characteristics of the Chinese system

The social and economic conditions in the People's Republic of China should be studied in detail by international organizations for the benefit of Western Hemisphere governments.

These studies should include the examination of both short and long-term goals of the development plans, the achievements made and the organization required both to prepare the plans and to evaluate their results. Of particular interest would be the organizational aspect of the planning procedure, since it involves planning at the central as well as at the bottom levels, and a subsequent compatibilization process.

In addition, the studies should focus on agricultural organization and development, small-scale industrialization, the conservation of the human environment, the development of energy resources in general and the natural-disaster prevention planning and relief.

Study tours could be organized, through United Nations auspices, with participation of developing countries representatives, in order to learn full particulars on the subjects mentioned above.

In the case of the Central American Isthmus countries, these study tours should be undertaken to analyze the following areas:

- i) The agricultural development sector, including a detailed examination of the basic production organization.
- ii) The implementation of small-scale industries, with special reference to agroindustry and to basic factories for farm implement and home appliance manufacturing.

/iii) The

- iii) The undertaking of small-scale electric generation projects.<sup>1/</sup>
- iv) The conservation of the environment and its relation to development.
- v) The prediction and prevention of, and the relief organization for, natural disasters.
- vi) The assessment of economic and financial feasibility of the Chinese project undertakings, employing Western economics and financial accounting procedures.

Here again the UNEP should take a leading stance in organizing these study tours. The ECLA would be expected, of course, to collaborate in those fields which are of its competence.

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<sup>1/</sup> With participation of electric utility officials and agricultural cooperative leaders, which theoretically would be in charge of executing similar programmes.



Annexure 1

## LIST OF OFFICIALS INTERVIEWED BY THE MISSION

- Li Hsiang-yun: Deputy Director, Bureau of Water Conservancy & Electric Power, Hunan Province
- Hsu Tseng-ming: Chief of the Division of Agriculture and Water Conservancy, Hunan Province
- Tien Chang-yu: Vice Chairman of the Revolutionary Committee of Taoyuan County, Hunan Province
- Tsien Jen-cheng: Chief of the Agrarian Office of Taoyuan County
- Kao Chun-hung: Director of the Bureau of Water Conservancy & Electric Power of Taoyuan County
- Chen Kang: Deputy Director of the Bureau of Water Conservancy & Electric Power of Kwangtung Province
- Li Yen-fu: Chief of the Division of Agriculture and Electric Power, Kwangtung Province
- Lo Chou: Engineer of the Bureau of Water Conservancy of Kuangchow Municipality
- Hon Yeh-chuan: Director of the Bureau of Water Conservancy of Tsunghua County
- Ouyang: Vice Chairman of the Revolutionary Committee of Hsinhui County
- Tsao Yung-tong: Director of the Bureau of Water Conservancy & Electric Power of Hsinhui County
- Huang Kang: Head of the Headquarters of the Kutoushan Hydro-power Project of Hsinhui County
- Chen Wen-hsiu: Director of the Bureau of Water Conservancy and Electric Power of Anyang County, Honan Province
- Li Chao-chung: Director of the Bureau of Water Conservancy and Electric Power of Linhsian County, Honan Province
- Lu Teh: Director of the Bureau of Water Conservancy of Honan Province
- Chang Kuo-fu: Deputy Director of the Bureau of East China Power Management of Shanghai
- Hsueh Wei-ching: Vice Group Leader of the Group of Relations with Foreign Countries of East China Power Management of Shanghai

/Cheng Tai-yu

**Cheng Tai-yu: Vice-Minister of the Ministry of Water Conservancy and Electric Power**

**Lu Ping: Director of Foreign Department of the Ministry**

**Lo Fu: Chief of Foreign Liaison, Division of the Foreign Department**

**Chu Yun-pei: Staff member of the Foreign Liaison Division**

**Tan Ai-hsin: Staff member of the Foreign Liaison Division**

**Hsu Hsin-yi: Staff member of the Foreign Liaison Division**

**Meng Chih-min: Staff member of the Foreign Liaison Division**

**Tsou You-lan: Staff member of the Foreign Liaison Division**



