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LONG-TERM PLANS FOR SINKIANG IRRIGATION

Wang Ho-t'ing
(Ueda: 7262, 14528, 160)

Deficiency of water is Sinkiang's most serious problem. Situated in the northwest part of China, in the heart of Asia, this province is remote from oceans and beyond the reach of moisture-laden winds. Consequently, it suffers from lack of rainfall. With the exception of the high mountain ranges, the average annual rainfall of the province is less than 100 millimeters. Precipitation is greater in northern Sinkiang, although the average rainfall there does not exceed 400 millimeters.

Sinkiang is the most arid of the provinces in the northwest. It is, therefore, the province most urgently in need of irrigation. Statistics show that irrigation by human labor is practiced in 7 percent of the farms in Shensi, 21 percent in Kansu, 92 percent in Ninghsia, and 100 percent in Sinkiang. Without irrigation, there would be no production nor reconstruction.

How can irrigation be carried on in Sinkiang? Although the province lacks geographic proximity to large bodies of water and monsoons, it can obtain water from its elevated areas. The province has three large mountain ranges; A-erh-t'ai Shan to the north, K'un-lun Shan to the south, and T'ien Shan in the middle. The peaks of these ranges receive moisture from the winds that have blown over the Arctic and Indian oceans. The ice and snow formed during the winter thaw in the spring and summer to form rivulets that are the primary sources of water.

Since the source of water depends on the melted snow of the mountain ranges, farms and communities must necessarily be located at the foot of these elevations. Such settlements are called oases. Located in the northern foothills of the K'un-lun Shan are Erh-ch'iang, Ho-tien, and K'o-shih. In the southern foothills of the T'ien Shan are Ha-mi, Yen-ch'i, and A-k'o-su; towards the north are Ch'i-t'ai, Ti-hua, and I-li. Ch'eng-hua and T'a-ch'eng are situated at the southern slope of A-erh-t'ai Shan. Of the 1,850,000 square kilometers which constitute Sinkiang, the oases occupy only .007 percent. The goal now is to increase such oases by utilizing sufficiently all sources of water.

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Unless irrigation projects are developed and barren land cultivated, we will meet with defeat during periods of emergency. Sinkiang does not fear a lack of land; Sinkiang fears a lack of water. This factor is the cause of lawsuits at every planting season. The most severe conditions usually exist in Su-fu, So-ch'e, and A-k'o-su hsiens in southern Sinkiang. These three hsiens rely on the same source of water. The towns situated upstream have the advantage of the terrain while those located downstream suffer the disadvantages. Problems have become more difficult to solve with the ensuing years.

In 1946, after he had made an inspection tour of Sinkiang, Yu Yu-jen, chairman of the Control Yuan, said:

"Irrigation is definitely second to life in Sinkiang. With water, the desert may be transformed into fertile valleys; without water, the oases become deserts. Should the Central Government, in its program for reconstruction aid to Sinkiang, begin with irrigation, it will receive the blessing of each individual. In brief, the first step in Sinkiang's reconstruction is irrigation."

Topographical Features

The majority of the farms in Sinkiang rely on spring thaw for irrigation purposes. Although the snow-capped mountains form a huge natural reservoir, it is difficult to coordinate the water supply and agricultural requirements. Warm spring weather comes early to the plains before the snow in the upper regions has melted enough to provide sufficient water for young plants. This is the primary cause of irrigation problems and accounts for the abundance or deficiency of harvests. The period in which plants grow and reach maturity is very short. Lack of water during spring planting cannot be remedied later by a sudden ample supply. In the early autumn, floods may bring disaster.

The winter in northern Sinkiang lasts 5½ months, with a low of 30 degrees C below zero. Most agricultural areas in Sinkiang do not require water at this time. Therefore, it is essential to plan the construction of reservoirs and canals to conserve winter waters for use in the farming areas during the spring and summer. To achieve double results for half the amount of work depends on how the terrain is used in the construction of a reservoir. The mountains and valleys gradients. It is difficult to find a suitable place for the storage of water. However, there are natural marshlands and lakes which may be used for storage purposes. For example, the Red Wild Goose Lake (Hung-yen-ch'ih) (Ueda: 5985, 12957, 5986) in Ti-hua, the Po-ssu-t'eng Hu (1016, 4373, 13820) in Yen-ch'i, and the Hung-hai-tzu (5985, 1182, 2262) in Pa-ch'u.

Most of the rivers in Sinkiang are inland, that is, they lose themselves in the desert soon after they leave the mountain passes. This phenomena is commonly known as percolation.

The northern and southern Sinkiang basins are alluvial plains of the K'un-lun Shan, T'ien Shan, and A-erh-t'ai Shan. The fringe of each basin is elevated while the center is depressed. Along the foot of the mountains stretches the Gobi Desert whose width varies from several tens of kilometers to over 100 kilometers and is composed of gravel and coarse sand. The sand becomes coarser near the foot of the mountains. The lower fringe of the desert adjoins arable land where the present oases are situated. Canals bringing water into the farming region must pass through the desert. Two difficulties must be overcome.

1. Seepage.. The rate of seepage is about 4 percent every kilometer. With less water, there is more seepage. The greater the distance the more difficult it is to conduct the water.

2. Erosion. The canals go through the desert with a slope of about 1.5 percent. The desert soil offers little resistance to erosion from the current. When the upper part of the canals are eroded, the lower part becomes silted. Then the rate of flow decreases which results in more seepage. Before the use of cement began,

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the above-mentioned difficulties were hardly surmountable. Today difficulty in transporting cement is limited only by the financial angle. Sinkiang has not yet opened a cement factory, therefore, cement must be purchased from the Yao-chieh (8331 10620) Factory in Lan-chou which is 1,900 kilometers from Ti-hua.

Since most of its water is percolated, Sinkiang's underground supply is rich. In several areas in northern Sinkiang, the opening of wells has formed an important part of irrigation. Utilization of underground water has great potentialities if wells are improved and mechanized methods are used in drilling them. In the arable areas, the soil is brackish. The underground water table is higher towards the center of the basin and the brackishness is heavier. White crystals accumulate on the surface to form a salt bank. Fortunately, the arable surface is still extensive and the ground slopes enough to facilitate drainage and to wash out the salt. According to the experiments of old farmers, the brackish content of the soil or the water can aid in plant maturation. It has the value of fertilizer. Because of the limited manpower, under ordinary conditions fertilizer is not used. To conserve the soil, fallowing or plant rotation is practised.

History of Present Systems

Sinkiang has a long agricultural history extending as far back as the Han Dynasty (206 BC). Postal service by courier was initiated and oxen and seeds were introduced during the reign of Yuan. Cultivation was largely south and north of T'ien Shan. During the Ch'ing Dynasty, Lin Tse-hsu proposed the use of wells. Tso Tsung-t'ang constructed irrigation canals with military labor. But the fact that irrigation is what it is today in Sinkiang may be credited to the people who, driven by the necessities of livelihood, struggled to dig canals and wells.

At present there are over 1,000 wells and more than 1,580 large and small canals in Sinkiang with an approximate aggregate length of 40,000 kilometers. The irrigated or cultivated area for the entire province amounts to over 19 million mou (one acre equals 6.6 mou). If the present population in Sinkiang is estimated at about 4 million, the ratio is approximately 4.7 mou of watered land for each person.

Old canals divert water from the mountain streams. The engineering work here was comparatively simple resulting in much seepage and lowered duty. Each canal is capable of irrigating only 10,000 mou. In southern Sinkiang, however, canals from the larger rivers are capable of irrigating several tens of thousand mou. The old irrigation systems do not have intake facilities and rely on temporary dikes. During high waters, these embankments are of no avail. Division of water was determined by custom and resulted in much confusion during periods of shortage.

Beginning in 1941, modern irrigation engineering was introduced. The project included: the Yu-mung (10709, 11919) Canal in Sui-ting (I-[illegible]), the Ch'in-yung (4557, 2963) Canal in Ti-hua, the T'ien-ch'ih (1947, 5986) Canal in Fou-k'ang, and the Hsin-sheng (4376, 7770) Canal in Sha-wan.

Construction projects on a larger scale which are currently in progress are: the Ho-p'ing (1263, 2899) Canal and the Red Wild Goose Lake Reservoir in Ti-hua, the West K'o-k'o-ya-erh (4869, 4869, 12962, 7043) Canal in Shan-shan, the Wei-kan Ho (6351, 2897, 6045) Diversion Gate in K'u-ch'e and three diversion gates at K'u-ch'e, Sha-ya, and Hsin-ho. Recently planned ones include the Hsin-chung (4376, 3203) Canal in Ha-mi, the Hung-hai (8739, 6182) Reservoir at Pa-ch'u, the Hsi-ta (10820, 1946) Canal at A-k'o-su, the K'ai-tu (12716, 12188) Ho Canal at Yen-ch'i, and the T'ieh-kan-li (12654, 2897, 12372) Canal at Wei-li.

Besides the canal system, there are three other methods of irrigation in Sinkiang: ponds, wells, and "qanats." Ponds are found at Ch'ang-chi, Ch'ien-te, and other hsiens in northern Sinkiang. Wells are scattered throughout the province. Qanats occur largely in Shan-shan, T'u-lu-fan, T'o-ko-hsun, and Ha-mi. These four hsiens are an area especially difficult for canalization. The qanats here are actually

surface wells or tunnels. They draw underground water through gravitation. One qanat can irrigate an average of 40 mou in Ha-mi, or about 250 mou in T'u-lu'fan, Shan-shan and T'o-k'o-hsun. The largest is able to water about 800 mou. This form of irrigation was first introduced in Sinkiang 200 years ago. It is known locally as K'an-erh-tzu (1680, 574, 2262) and is similar to the Persian term, "kariz." There is a possibility that this system of irrigation was introduced from Persia.

The qanats in Sinkiang, except for those which use timbering in certain places as protection against shifting sands, all rely on soil resistance to support the perpendicular shaft of the qanat and the shape of the subtunnel. Consequently, the amount of water must be limited. Moreover, the qanats must be sifted and dredged annually. Labor and maintenance costs of each qanat are high.

A comparison of expenses for each mou of watered farm land shows that canal irrigation costs the most.

Future of Possibilities of Irrigation

What are the possibilities for the expansion of irrigation in Sinkiang? To answer this question, it is necessary first to make an estimate of the sources of water. The sources of water in Sinkiang are not as scarce as some people think and not as much as some oldtimers estimate. The province's supply of water may be very meager, but, if fully and economically utilized, it can be directed toward future reconstruction.

According to early estimates, the average low-water discharge of rivers in Sinkiang is generally about 2,000 cubic meters per second. If spring and underground water which can be utilized are discharged at 300 cubic meters per second, the total would be 2,300 cubic meters per second. Calculating that an average of one cubic meter per second could irrigate 10,000 mou, the total figure would irrigate 23 million mou. With the exception of farms already in existence, complete utilization of the present sources of water, without any kind of storage, would result in irrigation of about 4 million mou. If the summer and autumn flood waters and the unused water of winter can be stored, and if the source of water can be increased 300 cubic meters per second, it would be possible to irrigate about 7 million mou. If existing irrigation systems can be further improved, 10 million mou can be watered. This is a 50 percent increase over the present number of farms. Coordination between agriculture and an improved irrigation system would mean an increase in the quantity of production.

The generation of electricity also has possibilities of development and value. Due to the drop of the mountain streams, water power is available almost everywhere for the mechanization of industry and agriculture. For example, the Ka-man-kou (1h412, 6476, 6404), at the mouth of the Po-ssu-t'eng Hu, is about 11 kilometers long with a drop of about 60 meters and a normal discharge of 40 cubic meters per second. It is estimated to be capable of producing 25,000 horsepower. There are many other areas which can supply much water power for electricity. Water conservation in Sinkiang, now or in the future, should stress, above all, agricultural irrigation. Therefore, the prerequisite of hydraulic development shall be noninterference with the irrigation of farms.

As for water navigation, its development shall be confined to the Tarim Darya and its related waterways in southern Sinkiang. If this should succeed, then navigation will start from A-k'o-su to Wei-li, with the latter as the central line. From the north, the line shall start from K'ung-ch'iao Ho (2264, 12955, 6045) and run directly to Yen-ch'i and Ho-shih; the southern route shall start from the canal stipulated in construction plans, and run directly to Erh-ch'iang and vicinity. The entire line will be over 1,500 kilometers long and will benefit the transportation and marketing of agricultural products and the development of rich farms in southern Sinkiang. There is, however, much wilderness along this river. Shoals and other obstacles are manifold. The results of recent navigation tests show that a good deal

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of repair and engineering work is required before the river can become a through transportation system. Canalization of the net of waterways in Yen-ch'i and Erh-ch'iang is vast and cannot be completed in a short time.

There are two prevailing ideas concerning the future of irrigation in Sinkiang. One maintains that Sinkiang's supply of water is dependent on the snows of many years. Each year there is a gradual decline in the snowfall and the snow line rises higher and will one day be completely gone. This trend of thinking has no scientific basis. The source of water today is primarily the accumulation of snow on the high mountains. The amount of water is decided, on the one hand, by the amount of snow which fell during winter of the year before and, on the other, by the degree of warmth of spring of the current year. The amount of snow depends on changes in meteorological conditions. Without records which cover a long period of time, it is impossible to predict these tendencies.

The second contention is that since the oases of Sinkiang are surrounded by the desert, its sands and stones will continue to advance until they cover the oases completely. Such a danger does threaten the K'un-lun foothills in southern Sinkiang, but it is not difficult to conquer nature by human ingenuity if there is a reliable supply of water for the growth of forests.

Development Plans

The need for irrigation in Sinkiang is urgent. Hopes for its development are great. But the region is vast and irrigation engineering is extremely difficult. And, what is very important, there is no railroad in Sinkiang and there exists a severe lack of manpower, materials, and finances. To attain success within a short time is an impossibility. To meet this pressing need and to advance all types of irrigation constructions, it is necessary to obtain ample financial and technical aid from the Central Government. The people of this province should also exert their efforts and work with the government to subdue difficulties and rush the undertaking.

Widespread investigation, surveying, and hydrological tests are fundamental. It is important to draw up practical plans which can be carried out with present strength. Attention should be focused on irrigation and plans should be formulated to make self-sufficient those areas that lack grain, and to alleviate the people's hardships in those areas which lack water. Secondly, a network of waterways in southern Sinkiang should be opened, with Yen-ch'i and Wei-li as focal points, in order to facilitate the transporting and marketing of farm products. Thus, the economy of the villages can be raised.

Drainage engineering to improve the soil is another important project. Hydrological activities should be expanded to include power for industry.

The Sinkiang provincial government has already arranged a Sinkiang Five-Year Irrigation Reconstruction Plan based on the province's actual needs which, if finances permit, may be realized in several phases.

The grain production of Sinkiang, from the viewpoint of the entire province, is actually sufficient to meet the demand. However, the desert acts as a barrier, makes transportation difficult, and neighboring hsiens have difficulty helping each other. Studies of population and arable land distribution show that southern Sinkiang has a surplus of food production while northern Sinkiang has an insufficient supply. Ha-mi and Ti-hua suffer the most. In recent years, Ti-hua has relied on help from the various hsiens in the A-k'o-su district in southern Sinkiang. Ha-mi depends on Kansu Province for aid, but the transportation distance is more than 700 kilometers and there are many difficulties involved. To attain self-sufficiency in northern Sinkiang, it is imperative that irrigation be increased.

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In Su-fu and other districts in southern Sinkiang, the population is dense and distribution of the water supply is difficult. The burden of these adversities falls on the people. A reservoir must be constructed. Gates to divide the water should be constructed in order to permit a fair distribution. Only then can the difficulties of water consumption be solved. Geographically Yen-ch'i is in the heart of the province. It has a rich water supply and its uncultivated land is vast. Therefore, the greatest hope for the development irrigation in Sinkiang lies in Yen-ch'i.

Current engineering projects are curbed by lack of materials. Local substitutes must be used in order to avoid the difficulties involved in the acquisition of material from other provinces. There is a special need, for engineers who can accomplish the intricate task of scientific irrigation construction.

Water Conservation Bureau Activities

The Sinkiang Provincial Water Conservation Bureau was established in June 1946. In the past 2 years, it has attempted to bring irrigation to the entire province with the aid of the Sinkiang Irrigation Engineering Corps of the Ministry of Water Conservation. With limited technical personnel, it assumed the formidable task of irrigation engineering. The following is a rough outline of the past 2 years' activities of this bureau:

1. General Survey of Irrigation

In 1946 the Corps was dispatched to every part of northern and southern Sinkiang to conduct a general survey. The material thus collected is being compiled and will form the basis of a blueprint for Sinkiang's irrigation projects. Prior to this survey, there was no complete data on irrigation conditions from which to proceed.

2. Preparations for Hydrological Survey

A hydrological record is basic in carrying out irrigation engineering. Since 1947, this province has maintained a General Hydrological Board to promote hydrological activities. Three hydrological stations have been set up in the Ti-hua and Yen-chi area, five in Ha-mi, T'ien-ch'ih, and K'u-erh-lo areas. Others will be created from time to time to cover the entire province within a few years. They will be of great service in research studies on the amount of water required for all types of agricultural products and in the compiling of engineering estimates. Work was first started at the Ti-hua station early in 1948.

3. Surveying and Planning

The work of surveying, planning, and organizing has already been completed for the following projects:

a. Red Wild Goose Lake Reservoir at Ti-hua.

b. Ho-p'ing Canal at Ti-hua.

c. Shih-ch'eng-tzu Ho (7954, 1740, 2262, 6045) Irrigation Works at Ha-mi.

d. Wu-tao-kou (135, 12051, 5404) Irrigation Works at Ha-mi.

e. Wei-kan Ho Diversion Gate at K'u-ch'e.

f. Yen-ch'i Irrigation Works.

g. Ho-ching Irrigation Works.

h. Hsi-ta Canal at A-k'o-su.

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The Ha-mi irrigation schemes and the Ti-hua projects are both pressing, but because of engineering difficulties, they have not yet been started.

4. Red Wild Goose Lake Reservoir

Food production in Ti-hua, the capital of Sinkiang, is not sufficient and in recent years the population has increased. Ti-hua also lacks funds. The transportation of food over long distances increases its cost. Irrigation is absolutely necessary to increase local production and to provide the people with ample food.

Ordinarily the water supply of the Urumchi River in Ti-hua is insufficient. Consequently, the marshlands of the Red Wild Goose Lake must be utilized as a reservoir to conserve winter waters. The engineering work on this project was begun in August 1947. Utilizing equipment made to withstand the extreme cold, work was rushed to complete the reservoir. By the beginning of May 1948, the important construction of lower sluice gate was entirely completed. Storage capacity has reached 18 million cubic meters. When finished, the reservoir will be capable of storing 50 million cubic meters of water. It will rank second only to the Shan-hu-t'an (7284, 7343, 6545) Reservoir in Taiwan. To store water effectively, the depth of this reservoir must be 20 meters. The sluice gate uses a cylindrical valve. This valve and the opening and closing mechanisms were all manufactured in Ti-hua. Except for a small amount purchased from the Yao-chieh Factory in Kansu, most of the cement is a substitute made locally.

5. Ho-p'ing Canal

The soil in the vicinity of Ti-hua is rocky and sterile. However, the uncultivated area where Ti-hua adjoins Ch'ien-te and Ch'ang-chi is vast and the soil is fertile. It can be cultivated on a large scale. The source of water would be the Red Wild Goose Lake Reservoir and irrigation would be made possible by the Ho-p'ing Canal. Work was begun in March 1947. The main canal will be 35 kilometers long and will be lined entirely with slate to protect it against erosion. The distributing canals will be over 100 kilometers long. Two thousand mou of rice were planted in 1947. Over 10,000 mou were opened in 1948. Completion of the entire project awaits the granting of more funds. When finished, the canals will have the capacity of irrigating over one million mou of rice, wheat, and mixed cereals. The main part of Ti-hua's food problem may thus be solved.

6. Flood-Control Works at Wen-su, P'a-shih, and T'a-shih

The new channel of the K'un-a-la-k'o Ho (2614, 12830, 8354, 568, 6045), a tributary of the A-k'o-su River, is in the vicinity of Wen-su, P'a-shih, and T'a-shih. It is over 10 meters above the old channel. Fertile alluvial plains along the old channel have already been cultivated to the utmost and comprise what are known today as Wen-su, A-k'o-su, etc. The P'a-shih and T'a-shih terrain is treacherous. As soon as the dikes burst, the three hsiens of Wen-su, A-k'o-su, and A-wa-t'i are inundated. Work on this important flood-control project began in March. Activated by local citizens, with the aid of troops stationed there, the construction was completed in June 1947. Two flood-control projects are still pending: (1) the Yu-me-ta Ho (7261, 1859, 1946, 6045) of Ho-tien, Lo-p'u, and Me-yu hsiens; and (2) the Hu-t'-u-pi Ho (1251, 1646, 1373, 6045) of Ching-hua Hsien.

7. Repairing of the T'ien-ch'ih Reservoir

The T'ien-ch'ih Reservoir is situated halfway up Po-k'o-ta (1016, 568, 12052) Shan, 30 kilometers southeast of Fou-k'ang county seat. It is the second most important reservoir in this province. Built in 1943, it suffered damages in 1945 because the remoteness of its location hampered control. Repairs were made in 1947.

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8. Wei-kan Ho Diversion Gate for K'u-ch'e, Sha-ya, and Hsin-ho

K'u-ch'e, Sha-ya, and Hsin-ho all rely on the Wei-kan Ho for irrigation. Situated farthest downstream, Sha-ya annually has trouble with the other two hsiens over the division of the water. To equalize the distribution of water and to settle these yearly disturbances, the construction of embankments and a diversion gate is being planned. The orifice of the gate will be regulated according to the actual farming area of each hsien and the transit conditions of water, so that automatically there will be a fair distribution of water. Started in September 1948, this project is in positive stages of progress.

9. West K'o-k'o-ya-erh Irrigation Works

T'u-lu-fan, Shan-shan, and T'o-k'o-hsun are the world's most noted swamps, averaging about 150 meters below sea level. Although the latitude is 43 degrees north, the temperature is very hot. Planting is possible only during two seasons of the year. The sources of water are all lost in the desert. Since there are many obstacles to the opening of a canal, irrigation depends on qanats and wells. But large-scale expansion of qanats would result in their being too close together and one would flourish while the other would be exhausted. Besides extending, repairing, and improving already existing qanats, it is better not to plan any new ones. Although it is possible to dredge wells or use the drainage method, there are limitations. It appears that canals, which lead water directly from the mouth of the stream, remain the only scientific means by which the water supply and farms in these three hsiens may be increased.

Success is usually guaranteed when cement is used to line a canal. The great amount of cement needed now, however, not only requires inaccessible funds but entails difficulties of transport. The use of cement substitute also incurs huge costs. Under such perplexing conditions, the most economical and durable paving material, according to the results of tests, is locally extracted slate. Upright slate, if arranged properly on the desert slopes, can resist erosion and reduce seepage. There are two reasons for this: (1) since the canals use a larger channel, about 2.5 meters wide, there is less opportunity for seepage; (2) since the fissures of the upright slates permit silting up of loose soil, seepage is gradually reduced.

The amount of water of K'o-k'o-ya-erh-kou is comparatively great and the desert, as a barrier, is comparatively small (the canal penetrates about 32 kilometers into the desert). Therefore, expansion should be promoted after this project is started and produces positive results.

10. K'ai-tu Ho Irrigation Works at Yen-ch'i

The K'ai-tu Ho at Yen-ch'i has a rich supply of water. There are broad level plains on both sides of the river. In the past, because the problem of land rights was never legally settled, water was left to flow unchecked and the fertile [illegible] was permitted to go to waste. The minimum water discharge in this river is [illegible] cubic meters per second and it is capable of irrigating about 2 million mou. The area to be served is extensive and requires a detailed survey and application of a practical and complete development plan.

To meet present urgent needs, a portion of the canal should be constructed so that cultivation of a portion of the land can be initiated. With the exception of large-scale surveying to be done in 1949, work is proceeding on the opening of a distributing canal from the banks of the K'ai-tu Ho which will supply water to existing canals, and on the addition of several lateral canals.

11. Surveying the Tarim Darya in Wei-li

In 1944 the channel of the Tarim Darya in Wei-li Hsien was changed to flow eastward. It joined the K'ung-ch'iao Ho only to be lost in the Pai-lung-tu (7709, 14876, 1768) desert. The old channel ran dry and affected the water supply of the several hundred kilometers of land stretched along the banks of the Tung Ho (4765, 6045) from T'ieh-kan-li to Erh-ch'iang. On the other hand, the farms in the vicinity of Wei-li were confronted with the danger of flood or brackish water. The people of this area pleaded for restoration of the old channel to alleviate their hardships.

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It was orginally planned to block the mouth of the upper reaches of the Ying-erh-mai-li (9795, 7043, 11398, 12372) River (directly south of Lun-t'ai, about 200 kilometers from Wei-li) to restore the old channel. It later appeared that although the volume of water of the Tarim Darya was great during seasonal floods, nevertheless, when the farms needed water badly, none was to be had. This is because each year the farms along the tributaries above, such as the Yar-erh-ch'iang Ho, K'o-shih-k'o-erh (1392, 180, 1392, 7043, 6045) Ho, A-k'o-su Ho, and the Wei-kan Ho, increased in number and more water was used for irrigation purposes. Downstream, the discharge was reduced to a mere trickle. The minimum water discharge was only about 10 cubic meters per second.

If the old channel is used, the long desert stretch creates so much seepage and evaporation it is difficult for the water to reach T'ieh-kan-li. But as soon as the channel was changed for this reason, it could not reach Wei-li. There will also be many obstructions, in the development of water transport. As a result of research, it was decided to change the channel at the lower part where the Tarim Darya joins the K'ung-ch'iao Ho. Dikes and barriers will be constructed in the area of Wei-li. Water will be led by canals, which will be constructed according to plan, in the old channel. In such a fashion, the minimum water discharge of the Tarim Darya may be benefited by the excessive supply of the K'ung-ch'iao Ho. And again, it may be connected to the proposed reservoir at Po-ssu-t'eng Hu. The water supply may be thus regulated.

12. Hung-hai Reservoir at Pa-ch'u

Pa-ch'u is situated farthest downstream on the Yeh-erh-ch'iang and K'o-shih-k'o-erh rivers. In the Su-fu district it is most seriously affected by lack of water. The other hsiens, located upstream and benefited by their positions, exhaust the supply for irrigation purposes. What remains is not much. The course of the river is several hundred kilometers and the river bed is sandy. At low water, there is much evaporation and seepage. Thus, at times Pa-ch'u has little water, sometimes none. Planting depends on the flood waters of June and August. Crops are mostly autumn ones. During the dry period, from January to April, the hsien faces a problem of water for drinking purposes. Ten kilometers southeast of the city there are three swamp areas, Hung-hai (6134, 6182), Ku-hai (1142, 6122), and Shao-k'un (5187, 1289) which extend several tens of kilometers. Some of the excess winter water and summer flood waters flow to this region where the accumulation forms a lake. There is an abundant growth of reeds. Should this favorable spot be utilized for the construction of a reservoir, and embankments and diversion gates be built at Yen-erh-ch'iang Ho, it will be possible to store these excess waters. According to survey estimates, the volume of water which may be stored is over 100 million cubic meters. The desperate water problem of Pa-ch'u can thus be solved.

Surveying is now in progress on this valuable project.

13. Small-Scale Irrigation Schemes

With the exception of large engineering projects which will be handled directly by the government, lesser projects such as repairing old canals, mending dikes, adjusting wells, dredging wells, constructing small reservoirs, opening small canals, etc. shall be assumed by the local citizens with financial supplementation and technical assistance from the government. These projects were started in the past, but, if seriously and universally pushed forward, they would serve to supplement the shortage of large-scale irrigation. In some areas which face a scarcity of water, there is definite limitation to the development of small-scale irrigation schemes. Therefore, the solution of a great portion of the pressing water conservation problems in this province still depends on the initiation of large-scale irrigation.

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