IRRIGATION SYSTEMS, MANAGEMENT AND CENTRAL POWER: A STUDY OF THE RELATIONSHIP BETWEEN HYDRAULIC TECHNOLOGY AND SOCIETY IN SUI AND T'ANG CHINA

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Introduction

Within the geographical framework in which China's fascinating history is enacted, the nature-given contrasts are immediately visible. Throughout the length and breadth of the country, the landscape interchanges between barren mountain chains and fertile lowlands. Arid desert reaches are succeeded by enormous plains with copious rainfall and many rivers. This is the heterogeneous geographical pattern of the country.[1]

Although the Middle Empire can hardly be claimed to comprise a homogeneous unit, the Tsinling mountain chain in central China does draw a clear line of demarcation between two main types of society. From the Kunlun massif in northern Tibet, the Tsinling chain stretches to the east and west and marks a solid, climatic borderline. Here, the subtropical southern zone is left behind and replaced by the northern temperate zone -- hereby radically changing the premises for agriculture. The precondition for irrigating fields disappears on the arid plateaus where wheat and millet take better root in the dry soil. In a comparison between north and south, it is the unequal conditions for cultivation which characterize the portrait of China.[2]

In spite of the relatively unfavorable climatic conditions in northern China, it was nevertheless here that Chinese agriculture originated, specially near the Yellow River's (Huang Ho) central reach and around the loessial soil

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of this river valley which, as soon as it receives water, is ideal for agriculture.[3] Unlike southern China, precipitation in the north is irregular and often inadequate. Under the burning sun of the north, the small amount of rain and the nature of the soil mean that water supplies are an indispensable condition for agriculture. The foundation for Chinese agrarian society has therefore always been found in the great river valleys and this provides an indication of the decisive significance of rivers.[4]

Fortunately, the area beneath these remote skies was enriched by nature's hand through a superabundance of rivers. The entire hydrological basin of two of the world's most extensive river systems, the Yellow River and the Yangtze Kiang, are within Chinese territory and respectively north and south of the Tsinling mountain chain. The sources of the Yellow River and the Yangtze Kiang both rise in high-lying mountain areas and have an extremely great fall in their respectively 4,300 and 5,100 kilometer long, meandering courses from the west to the east. Year in and year out, the Yellow River drains the greater part of northern China proper, while the Yangtze Kiang drains an area twice the size in the south.[5]

Enormous distances, impassable mountains, unusual soil and climatic conditions and endless rivers, all created a natural basis for the development of irrigation systems of various kinds. South of the Tsinling chain the need was for irrigation systems in general, while irrigation systems in the north primarily took the form of canals.[6]

The Chinese society, where control of the agrarian-based economy was dictated by considerations connected with the fundamental division of labor between town and country, was thus dependent on irrigation systems. This was also the case in China under the Sui and T'ang dynasties (589-618 and 618-906), which were characterized by a relatively powerful central government, and the pursuit of extensive construction projects. But the central question is, was the power of the state built, for climatic reasons, upon the need for such irrigation systems,[7] or was the opposite of this controversial claim the case? Was there room between these two extremes for a smaller and more flexible contractor than the state when it came to constructing irrigation systems? In order to reduce this investigation to manageable proportions, the following article, which takes the period under the Sui and

T'ang dynasties as its point of departure, examines the classic question of the degree to which the state was actually involved in the construction of irrigation systems.

The Administration System

A storied myth asserts that the founder of the Hsia dynasty (2200 BC-1766 BC), the hero Yu, fought floods and regulated the rivers in the area where his people lived. This ancient legend is rather doubtful, however. Slightly less than a thousand years later, when the Shang dynasty (1766 BC-1122 BC) held the central power, there was more dependence on precipitation than on irrigation systems as far as agriculture was concerned.[8]

The story of Yu and his unflagging efforts cannot be verified for a simple, yet decisive reason: the absence of source material. To date, the legend has therefore typically been ascribed to literature in the guise of poerty. The first written evidence which can supplement the archaeological material appears only under the Shang dynasty. The nature and extent of this source material, however, excludes a more precise determination of dates. From the Chou dynasty (1122 BC-221 BC) there is a more evenly distributed source material of such a character that it allows China to enter the unambiguous light of chronology in 841 BC.[9]

We should thus be on more secure ground with the Sui and T'ang dynasties (589-618 and 618-906). This historical period has left a material situation which is both rather weak and very strong at the same time. By far the larger part of the material stems from a unique find made in the Tun-huang caves at the beginning of this century. Among thousands of documents - the main source of our knowledge of the administration of irrigation systems - a rolled fragment of paper was found.[10]

Thanks to two other well-preserved collections of documents from the T'ang dynasty, *Po-shih liu-t'ieh* and *T'ang liu-tien*, a more detailed identification of the fragment became possible. In 1913, scientist Lo Chen-yu believed that he could identify the fragment as an elaborated and more detailed version of a shorter passage from *Po-shih liu-t'ieh*, which is ostensibly quoted from "The Statutory Instrument for the Department of Waterways" *(Shui-pu shih)*. With the help of various dating techniques, Lo Chen-yu also

demonstrated an internal connection between the fragment and *T'ang liu-tien*, which was published in 739.[11]

On the basis of this research, among other things, in 1936 the Japanese historian, Niida Noboru, could place the fragment from Tun-huang in a more precise framework. Noboru was thus able to prove that the fragment was actually part of the so-called Statutory Instruments *(Shih)* which were published in the autumn of 737. In 1940 the historian Masajiro arrived at the same result. Since then there has been broad agreement that the fragment is best understood as being "The Statutory Instrument for the Department of Waterways" itself.[12]

Although it is true that our knowledge stems mainly from this Statutory Instrument, on the other hand, it is also a relatively comprehensive source, containing 34 preserved regulations. In the nature of things, no precise, complete picture of the administration of irrigation systems throughout the Sui and T'ang dynasties can be expected solely on the basis of this treasure from an oasis town, Tun-huang, near the borders of Central Asia. But it does provide a snapshot from 737. This significant feature of the material situation naturally color research to a great degree.[13]

Two organs were in existence in the metropolis, Ch'ang-an, under the Sui and T'ang dynasties, the Department of Waterways (*Shui-pu*) and the Directorate for Irrigation (*Tu-shui t'ai*, later *Tu-shui chien*), both of which were concerned with the domain of irrigation systems (see Fig. 1). The Department of Waterways was a subsidiary department under the Ministry of Public Works (*Kung-pu*), which was also the lowest in rank with regard to prestige of the six ministries (*liu-pu*) under the State Department. In addition to the administration apparatus proper, the emperor had five directorates at his disposal, one of which was the Directorate for Irrigation.[14]

On paper, the Department of Waterways and the Directorate nevertheless did encroach on each other's preserves. This mutual overlapping was partly taken into account by the Statutory Instrument for the Department of Waterways, which was perhaps the primary motive for its publication. The Instrument was custom-made for co-ordination, both between centrally-situated authorities and between the authorities at a lower administrative level.

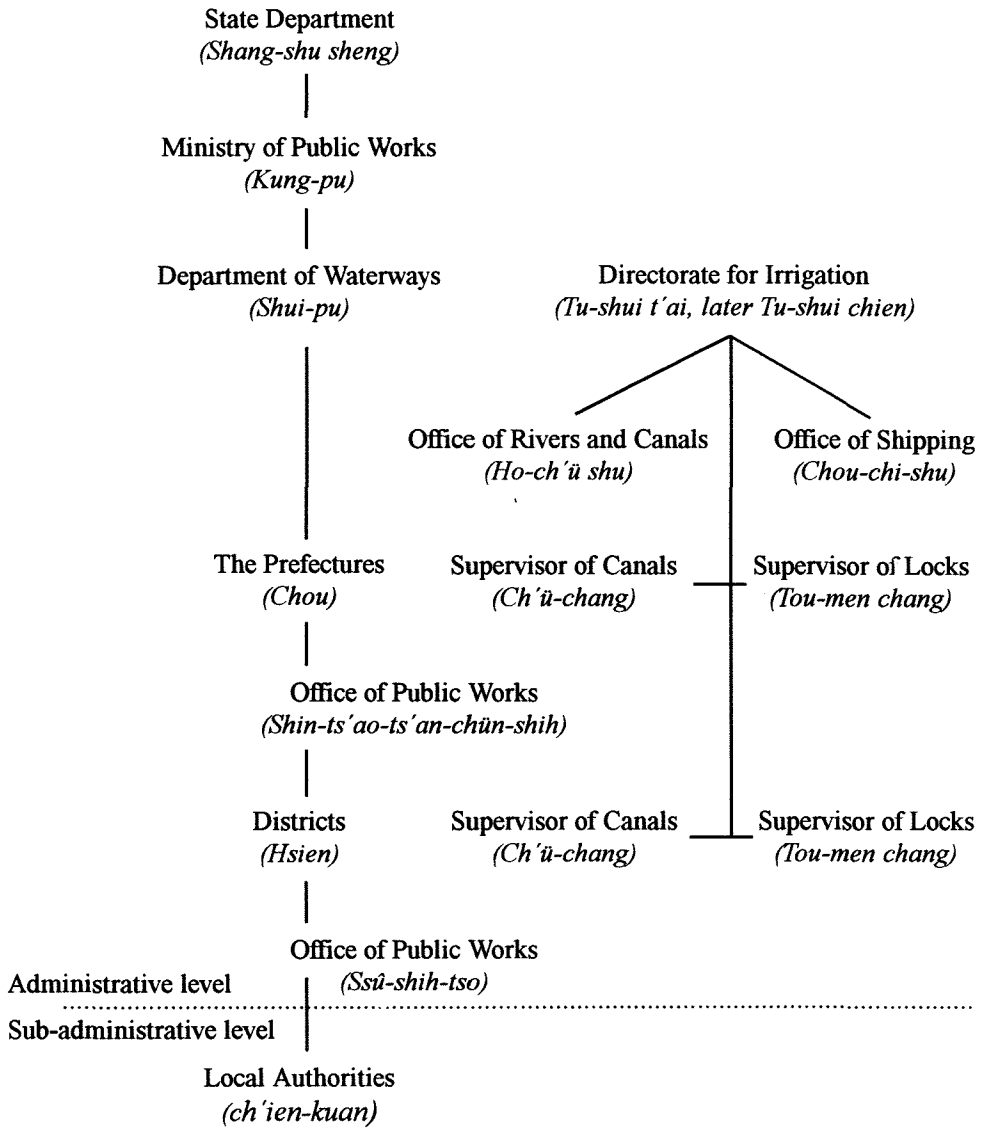

Fig. 1. The administration of irrigation systems under the T'ang dynasty. Only the main branches of the administration have been included.

The areas of responsibility which were assigned to the Department of Waterways and the Directorate for Irrigation were characterized by a lot of duplication. The responsibility for irrigation, river control, fishery, bridges, fords, waterways and water transport rested on the shoulders of both

institutions. Where the former also had supervision of watermills as part of its program, the Directorate had responsibility for swamps, canals, dikes and dams as well as shipping. To help it, the Directorate had two subordinate sections, the Office of Rivers and Canals *(Ho-ch'u shu)* and the Office of Shipping *(Chou-chi-shu)*, which relieved the pressure higher up in the system.

This assistance was more than needed. The Directorate itself was extremely understaffed with only five civil servants. In the Department of Waterways things were even worse. Four civil servants were all that could be obtained to perform the many tasks of the Department. This hardly confirms the opinion that the state was deeply engaged in the administration of irrigation systems.[15]

There are thus indications that the administration was more nominal than effectual. The combination of a small number of civil servants and a comprehensive register of tasks placed a natural limitation on the capabilities of the two institutions. Supervision of the irrigation plants and the strategically important bridges, which was among the responsibilities of the Department of Waterways, was thus limited to the area around the metropolis; whereas the Directorate failed completely to live up to its obligations in these areas. With regard to water transport and fishery, there is no relevant information and it has been assumed on good grounds that the long arm of the state did not even reach as far as the fringes of the irrigation systems.[16]

A number of other activities were also above the heads of the civil servants in the Department of Waterways and the Directorate in more than one sense. Larger regional projects were placed in the hands of the Ministry of Public Works (*Kung-pu*), which also cooperated closely with another of the five directorates, namely the Directorate of Public Works (*Chiang-tso-chien*).[17]

The stream of activities which flowed through the Directorate of Irrigation could hardly be regulated. The initiative shown by the Directorate was actually limited to the posting of supervisors. From time to time, a Supervisor of Canals (*Ch'u-chang*) or a Supervisor of Locks (*Tou-men chang*) popped up in the prefectures (*chou*) or the districts (*hsien*), where their visits were considered an honor.[18]

Where the Directorate's outgoing duties were of an investigative character, the activities under the Department of Waterways were more continuous. As part of the structure of the administrative apparatus, the Department had the advantage of being able to operate both at the level of prefecture and district via locally placed civil servants. Thus, at the level of the prefecture there was an Office of Public Works (*Shih-ts'ao-ts'an-chun-shih*), which at district level had the company of a corresponding Office of Public Works (*Ssu-shih-tso*).[19]

All the same, the local prefect often had to allow matters to take their own course. But when it came to supervising the irrigation plants and waterways he could have recourse to old, experienced hands within his profession. The prefect had the authority to appoint four former civil servants (*ch'ien-kuan*) who willingly lent a hand in a good cause.[20]

Waterways

Since the Han dynasty's (206 BC - 220 AD) golden age, China's agricultural center of gravity had gradually moved from the northwest to the central and lower Yangtze valley. This gradual movement from north to south created no great administrative problems during the Period of Disunity (220-589) as these areas were politically independent of each other.[21]

While the administrative center had remained in the northwest after the creation of the second empire at the end of the 6th century, the most important agricultural area was now completely in the hands of the landowners in the rich river valleys near the Yangtze Kiang. Here, China's rice granaries sprouted in the most literal sense. In its embryo state, the Sui dynasty's administrative and agricultural centers were thus staggered without being suitably connected. If the newly-won political unity was to last, the empire would necessarily have to be turned into a well-knit economic unit as well.[22]

In addition to this national aspect, the new central power also had a security problem - the defense of the empire. Outwardly this meant protecting the country against the always present danger posed by the neighboring nomadic societies of the northwest. On innumerable occasions, the uninvited foreigners had demonstrated their impressive riding technique on well-trained horses. Confronted with such skills, the self-sufficient local

militias were forced to throw in the towel, which emphasized the necessity for permanently garrisoned troops in the border regions.[23]

Under the T'ang dynasty, the idea of standing military colonies of a more professional character (*chien-erh*), which would be capable of taking up the challenge, was to become a reality. Although this military apparatus was not so expensive to maintain as the European mercenaries, for example, the solitary Chinese military colonies still had to be supplied with clothing and provisions.[24]

The empire's administrative center also had a similar everyday problem at close quarters. In the region which surrounded the metropolis, poor harvests occurred at regular intervals as a consequence of the unstable climate. And precisely in the metropolis, there were many mouths to feed with the high concentration of civil servants and other non-productive people who had no calluses on their hands as a result of laborious work in the soft loessial soil.[25]

Thus at the beginning of the dynasty's lifetime, approximately 6.1 million liters of grain had to be transported annually to the metropolis, mainly using the long and arduous route from Ho-nan. From this relatively modest beginning and in step with the development of a more complicated and expansive machinery of power, an almost insatiable need for grain began to make itself felt in the empire's administrative center.[26]

Ho-nan itself, however, was an extremely unpredictable larder. In the eastern province, Huang Ho was an eternal source of catastrophe when the river overflowed its banks. Through the almost 30-year reign of the Sui dynasty no fewer than seven severe floods were registered, all of which took place in Ho-nan or in the immediate vicinity of the province - a pattern which repeated itself under the T'ang dynasty. Of 305 registered floods, Ho-nan and the surrounding area were afflicted with approximately half; and, as if these were not enough, Ho-nan had to put up with periodic droughts.[27]

The first Sui emperor, Wen-ti (589-604), was not blind to all these conditions. Before China was ready for a new unity, he added a link to the network of waterways which would later bridge the deep gulf between north and south. As early as 584, Wen-ti ordered the brilliant architect, Yu-wen K'ai, to reconstruct a canal from the days of the Han dynasty, in these words:

> My rule over the country is dedicated to the promotion of beneficial things and the removal of the harmful. I regret both defects in the realm of public and private life. Therefore, starting from T'ung-kuan in the east and leading the water of the Wei from the west, a canal should be cut by human effort. The work is easy and can be accomplished.

The defects that Wen-ti referred to were largely caused by the silting up and seasonal drying out of the River Wei. A navigable canal which would connect the metropolis to the T'ung-kuan passage close to the confluence of the Huang Ho and the tributary Wei was therefore very much on the emperor's mind.[28]

Nobody should be able to say of Wen-ti that he had no sympathy for the sweated labor actually involved in the onerous task of canal building.

> I know that in the hot summer, work easily brings fatigue; but without temporary labor, how could permanent rest be made possible? Proclaim this to the people; they should know my wishes.

Yu-wen K'ai humbly took note of the emperor's orders and went about his business with a will. He fulfilled expectations completely when in 589, he proudly presented the Son of Heaven with an approximately 150 kilometer long canal which ran parallel to the River Wei. Significantly, the new connecting link was christened the Canal for Extended Connections (*Kuang-t'ung Ch'u*).[29]

Emperor Wen-ti was not an idle man. He used the period between 584 and 589 to restore a very old canal, Shan-yang tu, which had become silted over the years. In 587 he gave orders that this canal should be improved "to facilitate the transportation of tax grain." The Shan-yang tu canal now started at Yang-chou and described a gentle curve towards the north and Ch'u-chou so that the two waterways, the Yangtze Kiang and Huai, were connected. In this way, north and south became linked by what was only an approximately 150 kilometer long canal. Although the Shan-yang tu canal was hardly imposing, it was of great strategic importance.[30]

Wen-ti's second son, Yang-ti (604-617), however, had an even clearer view of the possibilities of waterways. As soon as Yang-ti assumed the imperial throne, he began his remarkable efforts to unite the empire completely by using the art of canal building. With Yang-ti, a perspective opened up which directed the construction of canals away from the petty, regional aspect and towards a national waterway system. Doing things by halves was not part of Yang-ti's constitution, which is why during his first five years as emperor, events followed one another in rapid succession towards the fulfilment of his great ambitions.[31]

Yang-ti took a rigorous line from his first year as the Son of Heaven. In an edict from 605, he ordered his faithful subjects to construct a canal, Pien-ho, (*T'ung-chi ch'u*) in order to connect Lo-yang with Ssu-chou, which lay close to the River Huai. By exploiting the existing rivers together with the Shan-yang tu and Pien-ho canals, an invaluable waterway was established between the Yellow River and the Yangtze Kiang. This enabled Yang-ti to celebrate his first triumph in the knowledge that the many, extensive branches of these two river systems had been interwoven for the first time in the history of the empire.[32]

Yang-ti stopped at nothing in connection with the construction of the Pien-ho canal. According to the Sui dynasty's standard history, (*Sui shu*), he mobilized more than one million laborers at the stroke of a pen. These men and women came from great distances. Workers streamed in from the prefectures between the Yellow River and the River Huai to take on together the enormous task of constructing the 40-meter wide Pien-ho canal. The project also included the construction of an imperial road along the canal with resting places situated regularly along the way. Shady willow trees were planted parallel to the imperial road. It was necessary to commandeer this enormous number of workers to prevent Yang-ti from being dishonored.[33]

Actual numbers vary from source to source. A detailed description of those employed on the Pien-ho construction is supplied in a section of a contemporary, anonymous source, "Record of the Opening of the Canal" (*Kai-ho Chi*):

> All men between the ages of fifteen and fifty were ordered to assemble by royal edict, all who tried to hide were punishable by decapitation... The laborers thus assembled numbered 3,600,000. Then each family was required to contribute a child or an old man, or woman, to prepare meals for the workers. Five thousand young and brave soldiers were ordered to be armed with sticks (to maintain discipline). Together with section chiefs and other administrators, the whole number of people employed in the canal amounted to 5,430,000.

Able-bodied or not, this staggering figure comprised more than ten percent of the country's population at that time.[34]

Looked at through these unofficial spectacles, Yang-ti's extravagant canal construction was thus accomplished through the ruthless exploitation of the human workforce. Here, brutality was the order of the day and the result was that, "when the workers were counted, two million and a half laborers and twenty-three thousand soldiers had been lost." Although the reliability of this source is doubtful, the figures recorded give an indication of the high price the population had to pay for the Pien-ho canal.[35]

When Yang-ti inspected the completed canal, the contrasts were placed in even greater relief. The emperor was a man who knew how to conduct himself and woe to that person who failed to fulfill his demand for 500 beautifully decorated dragon boats for him and his entourage. With much ado, Yang-ti examined the canal thoroughly, and on his way, repaid the compliment for this expensive canal trip, according to the "Record of the Opening of the Canal," with torments and tortures. Not quite without foundation, some grumbling was probably heard in out of the way corners as to the modest level of imperial appreciation. If nothing else, the ordinary people standing in Yang-ti's shadow could sense the atmosphere of the higher social strata and console themselves with the exotic stench that was their portion: the court's fragrant "perfume could be smelled for a distance of a hundred *li*!.[36]

After the success of the Pien-ho canal in 605, Yang-ti had really tasted blood. A new and longer canal, Yung-chi ch'u, would come into being in 608. The canal started from the Yellow River and ran in a northeasterly direction towards the Cho district in northern Ho-pei, i.e. in the area around

modern Beijing. No punches were pulled in connection with this canal either. "Over one million men and women from the various prefectures north of the Yellow River were mobilized by imperial edict to undertake the task." These words from the *Sui shu* can naturally be called into question, but under any circumstances the Yung-chi ch'u was completed in 609. Hereby, a direct waterway was constructed between the heart of China and the regions towards Korea, regarding which, it would shortly become apparent, Yang-ti had plans which would hardly bear the light of day.[37]

Yang-ti also made his influence felt at the other end of the country. In 610 he was thirsting after a connection to the regions around Hang-chou so that one of China's most significant rice-growing areas could also be drained of its wealth. In the same year therefore, an approximately 400 kilometer long, 35 meter wide canal was excavated, the Chiang-nan ho, which stretched from Jun-chou to its terminus at Hang-chou. After the completion of this work, Yang-ti could lean back with a sigh of satisfaction and note that in his time, the empire had been connected both in a north-south line and in an east-west direction.[38]

More canals were added later. But considered together, these five sections, Kuang-t'ung ch'u, Shan-yang tu, Pien-ho, Yang-chi ch'u and Chiang-nan ho, combined with smaller rivers comprised the famous Grand Canal - an appropriate designation for a work of construction which contributed to the fall of the Sui dynasty and still remains as a tremendously impressive piece of engineering work. While all succeeding generations, in general, would benefit from the Grand Canal, it was the T'ang dynasty, in particular, which would capitalize from this investment.[39]

Irrigation Plants

The laborious task of wresting the nutritious rice from the soil was particularly primitive until the 6th century. The typical method of cultivation, broadcasting, meant that peasants limited themselves to harvesting rice from the fields, where it had been sown with no other form of preparation. Such method had a number of problems. In the initial phase of cultivation, for example, the seeds often simply remained on the surface of the mud, where

the birds and strong winds were potential hazards until the rice seeds had established roots. Furthermore, this method of cultivation excluded adequate fallow periods, thus leaving the soil inadequately weeded and treated.[40]

During the T'ang dynasty, the peasants began to practice a more efficient method of cultivation called transplanting. In this method, small rice plants were grown in special beds and later transplanted manually in flooded fields. When harvest time approached, the water was drained off and the rice ripened. Although it was tedious process, transplanting made better use of the limited space and supply of water. It also promoted tilling, made weeding easier and opened the possibility for selecting the best and strongest rice plants, which together gave higher yields than broadcasting. This method of cultivation, incidentally, has remained largely in use up to our time.[41]

Methods of cultivation within agriculture were not the only ones which changed; new implements also made their appearance during the T'ang dynasty. Epoch-making inventions such as the harrow (*p'a*) and the ricefield plough, for example, gained a footing during this period. The areas worked by the harrow and plough, however, also had to be flooded before rice could be planted - a task which formerly required an enormous amount of manual work as water had to be lifted from one level to another. In a society based on rice cultivation, a labor-saving irrigation plant was therefore not to be sneezed at by the peasants who did all the work.[42]

Fortune smiled on the farmers when a more rational irrigation plant, known as *shui chhe*, *fan chhe* or, more colloquially, *lung ku chhe* came into general use around the year 600. *Shui chhe* differed from the ordinary irrigation plants because of an excellent mechanism: gearing. A chain of troughs lifted the water with the help of a crank; this technique relieved the peasants no matter whether the motive power was water, animals or people.[43]

Eventually, news of the *shui chhe* filtered through the metropolis. The emperor apparently looked benevolently on the *shui chhe* and evidently felt that it was absolutely necessary to put the machine into more or less systematic production. According to one of the T'ang dynasty's two standard histories, *Chiu T'ang shu*, the following was given out from the highest circles:

> In the second year of the Thai-Ho reign period, in the second month... a standard model of the chain-pump (*shui chhe*) was issued from the palace, and the people of Ching-chao Fu were ordered by the emperor to make a considerable number of machines, for distribution to the people along the Cheng Pai Canal, for irrigation purposes.

Regarding the conditions of production, the emperor thus let it be known that uniformity was a basic principle which would benefit the whole.[44]

Broadly speaking, the new method of cultivation and the improved implements meant greater rice yields so that southern China could gradually work up a larger surplus of rice seed. Thanks to the extended waterway system, the extra production could be shipped north where rice gradually came into favor with the people, at the expense of wheat. In the more elevated circles of the empire, rice actually became the favorite food in the 7th and 8th centuries. Apart from their worn out, bowed backs, the rice farmers, armed with patience, had thus won the draw with respect to the way they earned a living.[45]

Conclusions

China was preeminently an area of irrigation systems for many reasons. Floods, which have been entered into the annals of Chinese history with terror, could occur in the catchment areas of rivers. After such incidents, enormous areas would be saturated so that year after year farmlands would be waterlogged. At the other extreme, drought was a risk when precipitation was modest or completely nil. The loessial soil of northern China, from which the Yellor River derives its characteristic content of sediment, was only self-fertilizing when there was sufficient water. On the other hand, after rain, the highlands would be uniquely fertile. Other significant factors were the great distances and difficulty of transport between the country and the towns, which often went along pathways and roads that followed a certain route in impassable terrain. In the soft loessial soil of the north, a relatively heavy product such as grain, for example, which was a typical tax payment, was extremely difficult to carry over longer regional distances.

The state's administration of irrigation systems was not adequate for an efficiently functioning hierarchy. The Department of Waterways and the

Directorate for Irrigation were both instruments at the disposal of the state which could be used in many areas in connection with irrigation systems. The Directorate's role in the local community was less in evidence than that of the Department of Waterways. The prefects and district civil servants were at the disposal of the Department. They, however, were only able, with difficulty, if at all, to fulfill the demands made upon them, and typically had to let things slide. This void was filled at the sub-administrative level, where the primary responsibility for monitoring functions and the supervision of waterways rested.

Although the degree of competence at the sub-administrative level was not clearly defined, the distance between top and bottom was much greater. A certain inertia could also be felt with regard to communication. As the lack of civil servants was not compensated for within the framework of the administrative apparatus, it became almost meaningless and this implied inadequate control. The hollow administrative system meant that the peasants themselves must have taken up the problem of irrigation on their own initiative. This shows that the connection between the state and the irrigation systems at the local level was very tenuous. The dogma that, on climatic grounds, the power of the state was based on the need for irrigation systems is thus disingenuous.

The imperial rule of the agrarian-based economy was dictated by considerations regarding the division of labor between town and country. At the national level, a type of staggered division of labor between intellectual and manual work did exist. While the administrative and agricultural centers merged geographically under the Han dynasty, they gradually moved away from each other during the Period of Disunity. This problem was exacerbated under the Sui and T'ang dynasties as the empire's metropolis and the agricultural center of gravity were located in the highlands of northwestern China and the river valleys of the Yangtze Kiang respectively. Thus, canal building was undertaken with the goal of unifying the state.

The establishment of a national system of waterways solved the problem of the growing need for grain in the metropolis, thus reflecting the political realist attitudes of the state. But canal construction was still a two-edged sword for the Sui dynasty. On the credit side, the country gained a transport network through which the wealth of southern China could be steered

northwards to satisfy the need for rice and other necessities of life. In this light, the establishment of waterways must have been a success as it brought grist to the lucrative mill of commerce. On the debit side, the monumental task of canal construction drained the energy of the population on which the Sui dynasty relied. After less than three decades at the helm, the power basis of the state withered and the Sui dynasty fell.

The waterway system had yet another small advantage. The system could also provide water for irrigation, which was essential for the surrounding loessial soil and rice fields. Within the broad framework of irrigation systems, the interplay between different innovations, such as the *sui chhe*, allowed more efficient cultivation and higher yields. This probably released part of the labor force, which was the principal element in the massive canal building projects.

The Grand Canal was built on these premises. In combination with smaller rivers, the Grand Canal comprised five canal sections which were constructed according to an overall plan. Canal construction was thus conceived not on the basis of climatic conditions, but as an answer to the difficulties involved in distribution between the administrative and agricultural centers. Its motive was the burning question of the dynasty's survival, which is why construction progressed in giant steps, and in only five years, the empire was pieced together by a national waterway system. At this tempo, canal construction must have been extremely unpopular with the general population. But under any circumstances the Grand Canal stands as an example of *realpolitik* in its prime. The credit for this monument is still accorded to the extravagant emperor, Yang-ti. But the drudgery was left to the sorely tired Chinese peasants.

NOTES

1. Rhoads Murphey, "A Geographical View of China" in John Meskill, (ed.), *An Introduction to Chinese Civilization*, New York, 1973, pp. 516-550, esp. 531-532.

2. Ch'ao-ting Chi, *Key Economic Areas in Chinese History: As Revealed in the Development of Public Works for Water-control*, New York, 1970, (1936),

pp. 30-31. John King Fairbank, *China: A New History,* Cambridge, 1992, pp. 4-5. W. M. S. Russell, *Man, Nature and History,* London, 1967, p. 122.

3. Kwang-chih Chang, "Chinese Archaeology" in John Meskill, (ed.), *An Introduction to Chinese Civilization,* New York, 1973, pp. 380-415, esp. pp. 392-393. The loessial soil of the Huang Ho valley was probably deposited by the violent storms of the Ice Age. John King Fairbank, Edwin O. Reischauer, and Albert M. Craig, *East Asia: Tradition and Transformation,* London, 1973, p. 11. Ray Huang, *China: A Macro History,* New York, 1990, p. 20.

4. Fairbank, Reischauer and Craig, *op. cit.*, pp. 10-11. Karl A. Wittfogel *Wirtschaft und Gesellschaft Chinas: Versuch der wissenschaftlichen Analyse einer grossen asiatischen Agrargesellschaft,* Leipzig, 1931, p. 88 and p. 229.

5. Murphey (1973), *op. cit.*, pp. 516-550. When the Yellow River enters the lowlands it deposits yellow silt which stems from the great loessial plateaus in the west, hence its name. The Yellow River thus runs for the final 800 kilometers through fertile plains and delta areas deposited by the river itself. Fairbank, Reischauer and Craig, *op. cit.*, p. 9 and p. 11.

6. Chi, *op. cit.*, p. 12 and pp. 24-25.

7. The most prominent 20th century exponent of this view *is* Karl A. Wittfogel, *Oriental Despotism: A Comparative Study of Total Power*, New Haven, 1957.

8. Derk Bodde, *Chinese Thought, Society, and Science: The Intellectual and Social Background of Science and Technology in Pre-Modern China*, Honolulu, 1991, p. 53. Fairbank, Reischauer and Craig, *op. cit.*, p. 21 and pp. 30-31.

9. Wolfram Eberhard, *A History of China*, London, 1950, pp. 14-15. Fairbank, Reischauer and Craig, *op. cit.*, pp. 20-22. John Meskill, "History of China" in John Meskill (ed.), *An Introduction to Chinese Civilization*, New York, 1973, pp. 4-338, esp. p. 6.

10. Meskill, op. cit., p. 93. Denis C. Twitchett, "Some Remarks on Irrigation under the T'ang", *T'oung Pao*, Series II, Vol. 48, pp. 175-194, 1975 (1960), esp. pp. 176-177.

11. Denis C. Twitchett, " The Fragment of the T'ang Ordinances of the Department of Waterways Rediscovered at Tun-huang", *Asia Major*, New Series, Vol. 6,

Part I, pp. 23-79, 1958, esp. pp. 23-24 and p. 42, note 15. Denis C. Twitchett, *Financial Administration under the T'ang Dynasty*, Cambridge, 1970 (1963) p. 335.

12. Twitchett (1958), *op. cit.*, p. 24. Twitchett translated the Instrument into English, apart from the introduction and conclusion which are missing.

13. Jacques Gernet, *A History of Chinese Civilization*, Cambridge, 1982, p. 246. Joseph Needham, *Science and Civilization in China, Vol. 4, Part II: Physics and Physical Technology. Mechanical Engineering*, Cambridge, 1965, p. 410. Twitchett (1958), *op. cit.*, p. 38 and pp. 67-68.

14. Needham, *op. cit.*, p. 19, Twitchett (1958), *op. cit.*, p. 37. Twitchett (1975), *op. cit.*, pp. 177-178. The six Ministries (*liu-pu*) functioned under the State Department as follows: Revenues (*Min-pu*), Rites (*Li-pu*), The Military (*Ping-pu*), the Judicial system (*Hsing-pu*), Public Works (*Kung-pu*) and Personnel Matters (*Li-pu*). This distribution of the administration's executive organs can be recognized under all following dynasties right up to the 20th century. Michel T. Dalby, "Court politics in late T'ang times" in Denis C. Twitchett (ed.), *The Cambridge History of China, Vol. 3, Part I: Sui and T'ang China, 589-906*, Cambridge, 1979, pp. 561-681, esp. p. 590. Fairbank, Reischauer and Craig, op. cit., p. 105. Arthur F. Wright, "The Sui Dynasty (589-617)" in Denis C. Twitchett (ed.), *The Cambridge History of China, Vol. 3, Part I: Sui and T'ang China, 589-906,* Cambridge, 1979, pp. 48-149, esp. p. 82.

15. Wittfogel exaggerates on the question of the state's engagement in the administration of the irrigation system under the Sui and T'ang dynasties. See Twitchett (1975), *op. cit.*, pp. 193-194.

16. Twitchett (1958), *op. cit.*, pp. 37-38. Twitchett (1975), *op. cit.*, p. 179.

17. Twitchett (1958), *op. cit.*, p. 38 and p. 63, note 127.

18. *Ibid.*, p. 40. Twitchett (1975), *op. cit.*, p. 184.

19. Twitchett (1958), *op. cit.*, p. 38.

20. Twitchett (1958), *op. cit.*, p. 27. Please see note 36. Twitchett (1975), *op. cit.*, p. 180.

21. Chi, *op. cit.*, p. 9. Twitchett (1970), *op. cit.*, p. 84.

22. Etienne Balazs, *Chinese Civilization and Bureaucracy: Variations on a Theme*, New Haven, 1964, p. 60. Chi, *op. cit.*, p. 9 and p. 113. Fairbank, Reischauer and Craig, *op. cit.*, pp. 101-102.

23. Fairbank, Reischauer and Craig, *op. cit.*, pp. 154-156. Gernet, *op. cit.*, p. 247. Oven Lattimore, *Inner Asian Frontiers of China*, New York, 1949, p. 58 ff. Karl H. Ranitzsch, *The Army of Tang China*, Yorkshire, 1995, pp. 10-16, esp. p. 13. Twitchett (1970), *op. cit.*, p. 85.

24. Fairbank, Reischauer and Craig, *op. cit.*, p. 102. Rhoads Murphey, "The City as a Center of Change: Western Europe and China", *Annals of the Association of American Geographers,* Vol. 44, pp. 349-362, 1968, esp. p. 358. Twitchett (1970), *op.* cit., pp. 85-86.

25. Meskill, op. cit., p. 83. Twitchett (1970), *op. cit.*, p. 84.

26. Twitchett (1970), *op. cit.*, p. 85 and p. 89.

27. Fairbank, Reischauer and Craig, *op. cit.*, pp. 9-10. Shan-yu Yao, "The Geographical Distribution of Floods and Droughts in Chinese History, 206 B.C.-A.D. 1911", *Journal of Asian Studies*, Vol. 2, pp. 357-378, 1942-43, esp. pp. 367-368, table IV and p. 368, table V.

28. The passage is from Chi, *op.cit.*, p. 119. Fairbank (12), *op. cit.*, pp. 77-78. See also Arthur F. Wright, *The Sui Dynasty: The Unification of China, A.D. 581-617*, New York, 1978, p. 178. Wright (1979), *op. cit.*, p. 114.

29. The passage is from Chi, *op.cit.*, p. 120. See also Wright (1978), *op. cit.*, p. 178. Wright (1979), *op. cit.*, p. 115.

30. Quoted from Chi, *op. cit.*, p. 117. See also Chi, *op. cit.*, p. 118. Twitchett (1970), *op.cit.*, p. 188.

31. Raymond Dawson, *Imperial China*, London, 1972, pp. 48-49. Wright (1979), op. cit., p. 115 and p. 134.

32. Chi, *op. cit.*, p. 116. Twitchett (1970), *op. cit.*, p. 187.

33. Chi, *op. cit.*, p. 116. Gernet, *op. cit.*, p. 239. Wright (1978), *op. cit.*, p. 179. Wright (1979), *op. cit.*, p. 135.

34. From Chi, *op. cit.*, p. 123. Wright (1979), *op. cit.*, p. 128.

35. Quoted from Chi, *op. cit.*, p. 123. See also Chi, *op. cit.*, p. 124. Huang, *op. cit.*, p. 90.

36. Quoted from Chi, *op. cit.*, p. 124. See Twitchett (1970) on the course of the Pien-ho canal, *op. cit.*, p. 187. *Li* is a Chinese linear measure corresponding to approximately 500 meters.

37 Quoted from Chi, *op. cit.*, p. 120. Huang, *op. cit.*, p. 90. Twitchett (1970), *op. cit.*, pp. 188-189. Wright (1978), *op.cit.*, p. 179 and pp. 192-193. Wright (1979), *op. cit.*, p. 135 and pp. 144-145.

38. Balazs, *op. cit.*, p. 73. Chi, *op. cit.*, p. 114 and 118. Ranitzsch, *op. cit.*, p. 16. Twitchett (1970), *op. cit.*, p. 188.

39. Chi, *op. cit.*, p. 114 and p. 120. Fairbank, Reischauer and Craig, *op. cit.*, p. 96. Huang, *op. cit.*, p. 90. Meskill, *op. cit.*, p. 84. The present-day Grand Canal has a different course and is shorter than during the Sui dynasty. Chi, *op. cit.*, p. 114. For change over an eight-century span beginning in T'ang, see Robert Hartwell, "Demographic, Political, and Social Transformations of China, 750-1550", *Harvard Journal of Asiatic Studies*, Vol. 42, pp. 365-442, 1982, esp. p. 391.

40. Francesca Bray, *Agriculture*, Vol. VI Part 2 in Joseph Needham, *Science and Civilization in China,* Cambridge, 1984, pp. 251-252 and p. 288. Fairbank, Reischauer and Craig, *op. cit.*, p. 12. Gernet, *op. cit.*, p. 265. Meskill, *op. cit.*, p. 99.

41. Bray, *op. cit.*, p. 288. Fairbank, Reischauer and Craig, *op. cit.*, p. 13. Gernet, op. cit., p. 265. Meskill, *op. cit.*, p. 62.

42. Mark Elvin, *The Pattern of the Chinese Past,* Stanford, 1973, p. 118. Gernet, *op. cit.*, p. 265. Needham, *op. cit.*, p. 330.

43. Gernet, *op. cit.*, p. 265. Needham, *op. cit.*, p. 339.

44. Needham, *op. cit.*, p. 347.

45. Gernet, *op. cit.*, p. 265. Meskill, *op. cit.*, p. 62 and p. 99.