

HISTORICAL DEVELOPMENT OF THE GREATER CHAO PHYA WATER CONTROL PROJECT: AN ECONOMIC PERSPECTIVE

by

Leslie E. Small*

The Greater Chao Phya project is the largest water control project in Thailand, covering a total of 910,000 hectares (5.7 million rai) in the Central Plain. Although the project was originally designed to improve production conditions in the wet season, attention in recent years has been focused on dry season production. Disappointment with the rate of growth of dry season cropping has led to criticisms of the project and to proposals for further investment to improve the capability of the system to support dry season production.

In a recent study I have attempted to identify and measure the effects of this project on crop production (Small 1972). As a part of that study I investigated certain aspects of the historical development of the project, as recorded in published materials available in English. The information and conclusions resulting from this investigation are presented in this article.

Chronology of Events

In 1856 the Bowring Treaty between Thailand (Siam) and Britain went into effect. Ingram (1971) has documented the importance of this treaty in the development of the Thai economy in the latter part of the 19th and early part of the 20th centuries. A development of major importance was an expansion in the production and export of rice. This expansion, which was encouraged by both foreign demand and Thai

* Assistant Professor, Southern Illinois University. The research on which this article is based was undertaken as a joint project between Cornell University and the Faculty of Economics and Business Administration of Kasetsart University. I wish to acknowledge the substantial contribution made by Kasetsart University in the conduct of this research. In particular, I wish to acknowledge the assistance of my co-worker, Mr. Chamras Arunpoo, of Kasetsart University, who worked with me throughout the period of my research in Thailand. Financial support for the research came from the National Science Foundation, the South East Asia Development Advisory Group (SEADAG), and Cornell University.

government policies (Ingram 1971 : 75-87), necessitated the spread of rice production to areas where natural water conditions were less favorable than in the areas previously cultivated. This, in turn, appears to have led to an increase in the frequency of serious crop failures, which became of great concern to the government.

In 1889 the Siam Canals, Land and Irrigation Company, operating under a government concession, began digging canals in the largely unpopulated Rangsit area of the lower Chao Phya delta. By making the area accessible, and by permitting the drainage of the flood waters, these canals opened an area of about 142,000 hectares of land to cultivation (Thailand. RID 1927 : 2). The government had hoped that this type of "irrigation scheme" would prove to be a solution to the problems of unfavorable water conditions, and could eventually be extended to the rest of the Central Plain (Thailand. RID 1927 : 2). Difficulties with the Rangsit scheme soon demonstrated that such expectations were unrealistic. Although certain control structures had been built on the canals to regulate the drainage of the area, the system was unable to bring any additional water into the area in times of shortage. It thus was not able to deal with one of the major causes of crop failure. Furthermore, within a short time the canals began to silt up, making parts of the area inaccessible once again. By the turn of the century, less than 40 percent of the entire area opened up by the project had been cultivated (Thailand. RID 1927 : 2; Thailand. RID 1929 : 10). As a result of these problems it was decided to obtain the services of a hydraulics engineer to advise the Ministry of Agriculture (also known as the Ministry of Lands and Agriculture). The man selected, Mr. J. Homan van der Heide, arrived from the Netherlands East Indies in 1902.

In January of 1903 van der Heide submitted to the Minister of Agriculture a comprehensive report which was later published (van der Heide 1903), in which he proposed an irrigation scheme based on a diversion dam across the Chao Phya river near Chainat, and on a network of distribution canals which would carry the diverted water throughout the flood plain and delta of the Chao Phya river. In the lower delta region he also recommended the improvement of various canals by further excavation and by the construction of control gates to permit the

retention of water and to reduce the influence of the tides on the water supply. In effect, van der Heide thus proposed the construction of what is today known as the Greater Chao Phya project.

Approval was given to proceed with some of the improvements of the canals in the lower delta, and a Royal Irrigation Department (RID), or, more literally, a Department of Canals (*Krom Khlong*) was established within the Ministry of Lands and Agriculture, with van der Heide as Director-General. The main scheme, however, was postponed indefinitely, although it was suggested that all hydraulic works built in the future should be constructed in such a manner that they could eventually be combined into the master scheme proposed by van der Heide (Thailand. RID 1915a, vol. 3 : 10-12).

Van der Heide then developed plans for a less expensive project, known as "irrigation at reduced capacity" (Thailand. RID 1915a, vol. 3 : 16-17). The Siam Canals, Land and Irrigation Company apparently took an interest in one part of this plan, and petitioned the government for a decision (Thailand. RID 1915a, vol. 3 : 18). Thus in 1906 the government reviewed the entire question of irrigation. The decision was to postpone all of the proposals for at least two years (Thailand. RID 1915a : 19).

In 1908 the worst flood in 30 years occurred, causing serious damage to many of the canal control structures which had been constructed by the Department of Canals in the years since 1903 (Thailand. RID 1915a, vol. 3 : 23). Although there is no record of the effect of these events on the attitudes of the government ministers and advisers, it seems probable that they strengthened the position of those who opposed the irrigation proposals. In any case, early in 1909 the government decided to postpone indefinitely the construction of all irrigation works, whereupon van der Heide left the country (Thailand. RID 1915a, vol. 3 : 23-34). In 1912 the Department of Canals was abolished, being combined with the Public Works Department to form a new Department of Ways and Communication within the Ministry of Ways and Communication (Thailand. RID 1927 : 2; Thailand. RID 1915a, vol. 3 : 30).

The issue of irrigation was soon revived, however. In both 1911 and 1912 there were serious losses from drought, as the Chao Phya river

failed to reach the level necessary for normal inundation. This led King Rama VI to order the establishment of a commission, headed by Prince Rabi, Minister of Lands and Agriculture, to consider measures to avoid such problems in the future.

The commission reported that to concentrate upon rice production, and to supplement by scientific irrigation, the natural but capricious supply of water obtained from rainfall and river inundation, was the best means to secure agricultural results necessary for the regular provision of that public and private wealth, without which the welfare of the state and its inhabitants could not be assured (Thailand, RID 1927 : 3).

Arrangements were made for another irrigation engineer, Mr. Thomas Ward, to come to Thailand to develop proposals for the projects to be undertaken. Ward and his staff arrived in 1913, and the former department of Canals was re-established within the Ministry of Lands and Agriculture as the Royal Irrigation Department (*Krom Thot Nam*).¹ Mr. R.C.R. Wilson, one of Ward's assistants, was appointed Director-General (Thailand. RID 1915a, vol. 3 : 3-4).

Ward confirmed the soundness of the basic outline of van der Heide's proposals. He suggested, however, that the construction of the diversion dam on the Chao Phya river near Chainat should be postponed since the dam would be able to serve a much larger area than could be cultivated by the existing population (Thailand. RID 1915b : 1-4).² He thus recommended the gradual construction of a series of smaller "inundation projects" which could function even without the dam at Chainat, but which could later be linked together and converted into "irrigation projects" by the construction of such a dam.³ It was

- 1) In 1927 the name was changed to *Krom Chonlaprathan*, although the official name in English remained "Royal Irrigation Department". Thailand. RID 1963 : 7).
- 2) Another reason given for postponing this part of the project was that "the construction of such a barrage across the main artery of the country would present problems affecting much more than irrigation, the attempted solution of which might be dangerous at present in more ways than one" (Thailand. RID 1915b : 4). It is not clear from the report what "problems" Ward had in mind.
- 3) The term "inundation project" was used to refer to projects served by canals which could only receive water from the main river during periods of high river flow. "Irrigation projects" referred to projects served by canals which could receive water from the main river regardless of the level of the river (van der Heide 1903 : 32-33).

proposed that the area along the Suphan river (which is the area of the Sam Chuk and Pho Phraya subprojects of the present system) be developed first. Ward also proposed the construction of projects in the Pasak and Phetburi basins, based on diversion dams across each of these rivers (Thailand. RID 1915b).

Ward's report was submitted in February of 1915, and later that year the government decided to proceed first with the South Pasak project. This project, which required the construction of a diversion dam across the Pasak River, was designed to benefit the area of the old Rangsit scheme (the concession for which had lapsed to the government in 1914). The Suphan river project, upon which Ward had placed top priority, was postponed, and preliminary work in the Suphan area, undertaken in anticipation that this project would be approved, was terminated (Thailand. RID 1927: 8). It was reported that the decision to proceed first with the South Pasak scheme was taken "probably because it was considered inadvisable to disturb existing arrangements of landlord and tenant in the Rangsit area and elsewhere, which the opening up of big areas of land in Suphan, free to all, must have done" (Thailand. RID 1927: 6). Whether or not this is true, it is clear from a note of the Financial Adviser that the fact that the South Pasak project would improve conditions in an already populated area (in contrast to the Suphan scheme, which involved a largely unpopulated area) was a major factor in the decision (Thailand. RID 1929: 4-6).

Although the government had thus finally given its approval to a water control project, the effects of World War I resulted in slow progress in the actual construction. Funds were scarce; prices rose; and the import of equipment was difficult. As a result, the South Pasak project was not completed until 1922 (Thailand. RID 1927: 19). Work was then begun on the Suphan project, the first of the projects to be undertaken in the northern portion of the Chao Phya area. The first item constructed was the regulator on the Suphan River at Pho Phraya, which was completed in 1925. This was followed by the construction of the main distribution canals to carry the water diverted by the regulator (Thailand. RID 1927: 79-80). Work continued to proceed slowly, however, and it must be assumed that the depression of the

1930's, during which rice prices fell drastically, further slowed the work. The Pho Phraya section of the Suphan project was not completed until 1933 (Thailand. RID 1970b). During the 1930's the Suphan project was extended north to include the area of the present Sam Chuk subproject. Construction of a head regulator on the Suphan river near the amphoe headquarters of Sam Chuk began in 1935, but the entire project was not completed until 1950 (Thailand. RID 1970b).

World War II again put a temporary restraint on the construction of water control facilities. Shortly after the end of the war, the Director-General of the Royal Irrigation Department, M.L. Xujati Kambhu submitted a proposal to the Ministry of Agriculture for the construction of a diversion dam at Chainat, and of the headworks and canals required to carry the diverted water throughout the area of the northern section of the Greater Chao Phya project (Thailand. RID 1949). The proposal was submitted to the International Bank for Reconstruction and Development (IBRD), and in October 1950 a loan of \$18 million was granted to Thailand for the construction of the project (International Bank 1963 : 79-81). Construction on the dam began in 1952, and was completed in 1956. Work on the distribution canals lagged, however, and they were not complete until early in the 1960's.

Thus the system which van der Heide, in 1903, had suggested could be completed in 12 years (van der Heide 1903 : 124) was finally finished in the early 1960's. Even before completion of the system, however, plans were made for the construction of upstream storage dams on the Ping and Nan rivers (Thailand. RID 1949 : 37). In 1955, the U.S. Bureau of Reclamation completed the feasibility study for the first dam, known as the Yanhee or Bhumiphol project (United States 1955). The project was designed primarily for the production of hydroelectric power, although some flood control, navigation, and irrigation benefits were also expected (United States 1955, vol. 1 : 40). In 1957 a \$66 million loan from the IBRD was obtained for the construction of the Bhumiphol dam (International Bank 1963 : 79-81), and construction began in the following year (Thailand. RID 1962 : 15). Although the dam was completed in 1964, unusually dry conditions in the years 1965 to 1967 resulted in the failure of the reservoir to fill to the expected

level (Food and Agriculture Organization 1968: 10-11). As a result, the quantity of water available for irrigation was severely limited. Even in more recent years, dry season releases of water have been well below the originally estimated average of 260 cubic meters per second (Thailand. RID n.d.a; Thailand. RID n.d.b; United States 1955, vol. 1: 49).

In 1962 another loan (for \$5.6 million) was obtained from the IBRD for the Ditches and Dikes project. This project was designed to improve the distribution of water in the northern section of the Greater Chao Phya project. This was to be achieved by adding to the existing network of distribution canals and laterals a partial network of small ditches that would convey the water closer to the individual farms. Most of the construction of these ditches took place from 1963 to 1968, although in some cases work has continued up to the present time. Another improvement within the project area involves the provision of drainage facilities. Work on a system of drainage canals began in 1965, and is scheduled to continue until 1980.

The initial feasibility study for the second of the two upstream storage dams was completed in 1964 (Thailand. RID 1964). Compared with the Bhumiphol project, much greater emphasis was placed on the use of the water for irrigation in the dry season, although production of electric power is one of the purposes of the project. This project was also submitted to the IBRD, and after additional investigation (Thailand. RID 1965), a loan of \$26 million was granted in 1967 (Thailand 1967). The dam, known as the Phasom or Sirikit dam, was scheduled for completion in 1972 (Thailand 1967). In accepting the loan for this project, the Thai government agreed to conduct a number of studies relating to the agricultural, institutional, and engineering requirements for the successful use of the irrigation water that would be made available by the project. Reports from some of these studies and investigations are currently available (Food and Agriculture Organization 1968; Thailand. RID 1970a). A number of proposals for further development of the water control facilities have resulted, some of which are being tested on a pilot basis at the present time.

Objectives in the Development of Water Control

The major objective underlying the original development of water control in the project area was the reduction of the serious crop failures which occurred frequently in the late 19th and early 20th centuries. This was generally expressed as the objective of "stabilizing" production. The concept of "stabilization" was awkwardly but fairly clearly expressed in a report prepared by RID in 1929.

... In other words it may be stated that the main object in carrying out irrigation works is to admit of ordinary years when climatic conditions are such that an average crop might be expected, being converted into good years, and in years where conditions are distinctly unfavourable, and where only a poor crop could be expected, by the aid of irrigation works to produce in such a year an average crop (Thailand. RID 1929 : 12).

It was this single objective that dominated the discussion of the merits of water control throughout the first half of the 20th century.

In justifying the need for stabilization, the welfare of the farmers was sometimes mentioned (Thailand. RID 1927 : 3). Frequently, emphasis was placed on the importance of foreign exchange. Van der Heide noted that "Progress is going on rapidly and, in connection herewith, the wants of the Government and the people and the imports will continue to increase steadily Rapid increase of production and of export, to meet the increase of wants, is therefore incontestably necessary for Siam" (van der Heide 1903 : 62). In this respect, international competition was a factor. Thus in the introduction to Ward's report, the Minister of Agriculture states that the objective of the government in investigating and undertaking water control projects was "to enable the farmers of Siam to maintain against the increasing competition of neighbouring rice-growing states fostered by energetic governments, the position hitherto held by Siam in the rice markets of the world" (Thailand. RID 1915b : III).

Given the potential of the water control projects to open new land for cultivation, it might be thought that the expansion of the area under rice production was another major objective of the government in invest-

ing in water control. This was not the case, and one reason for the long delay in the development of water control appears to have been the concern that the construction of the proposed projects would permit land to be opened up too rapidly, with undesirable political, social, and economic consequences. One of the major questions raised when van der Heide's proposals were under consideration in 1906 was how to populate the area that would be under the command of the projects (Thailand. RID 1915a, vol. 3 : 19). And as previously noted, the choice of the South Pasak project over the Suphan project was based in part on the lack of population in the latter area, coupled with concern that the tenants in the Rangsit area would move to obtain the free land which would have become available in the Suphan area. Such a migration would not only result in losses to the landlords, but also in the probable abandonment of much of the recently developed land in the Rangsit area. There was also concern that the development of water control projects would allow foreigners to gain control of the land, and that further immigration of Chinese might be stimulated (Thailand. RID 1929 : IV, 2; Thompson 1906 : 75, 174). It can thus be seen that the major interest of the government was to stabilize production in areas that were already largely cultivated. Projects which provided a potential for the opening up of large new areas were generally postponed.

Dry season production was not a major objective of those involved in the original development of the system. Van der Heide suggested that a considerable amount of dry season production would be possible if the entire dry season flow of the Chao Phya river were diverted. He recommended the production of upland crops such as maize, beans, peas, cotton peanuts etc. He did not feel that a second rice crop would be appropriate, partly because of its greater water requirement, and partly because he felt it would result in soil and disease problems (van der Heide 1903 : 51-55).

With the rejection of his proposal, virtually all consideration of dry season irrigation ceased for over 40 years. The Ward proposals for the Chao Phya area were for "inundation" projects, which could not provide any water in the dry season. Although Ward and officials of the Royal Irrigation Department anticipated the eventual construction of a diversion dam near Chainat, they made no mention of the possibilities which this

might entail for the production of crops in the dry season. The only reference in this period to dry season production was made in a proposal for the dredging of the head of the Suphan river to permit water to flow in that distributary throughout the year. A brief comment was made that the dredging might permit farmers in the Pho Phraya area to raise two crops per year (Thailand. RID 1929 : 47).

The possibility of dry season crop production was again mentioned in 1949, when the Royal Irrigation Department proposed the construction of the Chainat Dam (Thailand. RID 1949). The main emphasis in this 1949 proposal, however, was on the system requirements for wet season production. Dry season cropping was dealt with almost as an afterthought. It was simply suggested that there would be enough water and good land to grow one million rai of soybeans in the dry season, half of which would be plowed under as green manure (Thailand. RID 1949 : 50-51). No consideration was given to the different requirement that such production would place on the system.

Thus it can be seen that prior to 1960, the primary objective of the Thai government in the development of the Greater Chao Phya project was the improvement of the conditions under which wet season rice production took place.⁴ Since 1960, however, the goals of the government have gradually shifted toward the development of the conditions necessary for dry season production.

Although the construction of the Bhumiphol dam provided some potential for irrigation, the main purpose of the project was power production. Furthermore, in the 1955 feasibility report, the brief discussion of irrigation emphasized the benefits that would result from the increase in water early in the wet season, when there is often a shortage of water for land preparation and transplanting. In the single paragraph devoted to a discussion of dry season irrigation, it was simply stated that the average dry season flow of the river at Chainat would be increased by 204 cubic meters per second, and that this quantity of water would be sufficient for the production of 2.3 million rai (368,000 hectares)

4) This discussion also demonstrates that Silcock's statement that "One of the original objectives of the Thai irrigation system was to promote double cropping of rice over much of the Central Plain" (Silcock 1970 : 64) is incorrect.

of upland crops (United States 1955, vol. 1 : 49). No consideration was given to other competing uses for the water (such as improved navigation below Chainat and salt water intrusion control), or the requirements to actually deliver the water to the farm fields.

It was the recognition of the fact that additional facilities were required to bring water to the farm fields that led to the proposal for the Ditches and Dikes program in the early 1960's (Thailand. RID 1961). The ditches were also designed to increase the effectiveness of the distribution of water in the wet season. In this regard it is interesting to note that Ward had proposed an even more complete system of ditches, even though dry season irrigation was not an element of his proposal. In any case, the Ditches and Dikes program was the first concrete step taken in the direction of modifying the original system to permit the effective use of water for dry season irrigation.

Finally, as noted in the previous section, the Sirikit dam project has been developed with the provision of water for dry season irrigation as a major objective (Thailand. RID 1964; Thailand. RID 1965). It is the potentially large volume of water which will be available upon the completion of this dam that has led to the various studies and proposals for further modifications and developments of the original system to enable it to support dry season irrigated agriculture.

Issues in the Development of Water Control

Extensive Versus Intensive Development

One issue which has been explicit or implicit throughout the history of the development of water control in the Greater Chao Phya project relates to the strategy to be followed for the ultimate development of a system in which the application of irrigation water and the drainage of excess water can be controlled on each individual farm plot. Conceptually, the various approaches can be placed on an "extensive-intensive" continuum. At one extreme is the extensive approach, under which a skeleton system of diversion structures and canals provides a supply of water to a large area, but on the basis of relatively uncontrolled field to field flooding. This network is gradually improved through the addition

of a drainage system, and of canals and ditches for the control of irrigation and drainage water on the individual farms throughout the area. At the other extreme is the intensive approach, under which an initially small area is provided with all the facilities necessary to control the flow of irrigation water to, and drainage water from, each individual field. The expansion of the system over time would thus involve a series of geographic steps, in contrast to the functional steps by which the system would be improved under the extensive approach.

Although van der Heide explicitly recognized the desirability of a system that provided the ability to apply water to and remove it from any farmer's field at will, he argued against immediate efforts to construct such a "thoroughly perfectionated irrigation and drainage system" (van der Heide 1903:33. 89-90). His argument was based on the grounds (1) that financial considerations made it necessary to use natural channels as much as possible, even though such channels were somewhat less than ideal for the purposes of the system, and (2) that farmers would not yet have the skills to fully utilize a more complete system. He therefore suggested that the construction of a drainage system be postponed, and that the construction of the small distribution ditches be left to "the local communities [which] will make them in the way of cooperation, customary to the country" (van der Heide 1903:91). Even if the people did not construct these ditches immediately, he felt that a system of field to field flooding would be satisfactory (van der Heide 1903:91). Van der Heide thus opted for a fairly extensive approach, whereby a large area would, within a short period of time, be served by a system which would function "fairly well" and which could gradually be improved as farmers learned to make use of the system, and as financial resources became available.

Ward recommended a much more intensive approach to the development of water control. He rejected the idea of the immediate construction of the dam at Chainat, not only because of its expense, but also because it could serve a much larger area than could readily be cultivated by the population. Furthermore, he disagreed explicitly with van der Heide's suggestion that distribution on a field to field basis would be satisfactory (Thailand. RID 1915a, vol. 3:4). He therefore urged the

construction of smaller projects which, in the words of the Minister of Lands and Agriculture, would be "thoroughly carried out to the last detail of the field embankments and ditches" (Thailand. RID 1915b: IV). He argued that it was particularly important for the first project to be constructed in this manner so that it could be "a shining example to the farmers throughout the country" of the benefits of "scientific irrigation" (Thailand. RID 1915b: 6). He felt that this would be important in gaining the support and cooperation of the farmers in the development of other projects. While recognizing that financial considerations would militate against this intensive approach, he pointed out that farmers were not likely to have either the technical expertise or the capital necessary to carry out the construction of the small ditches, drains, and other works required "inside the village." He therefore suggested that the government design and construct these works, but that the farmers be required to pay for them under long term credit arrangements (Thailand. RID 1915b: 17).

Although the government accepted some of the projects proposed by Ward, the above recommendations were not implemented. Thus neither the South Pasak project, which was the first to be built, nor the Suphan project, which was to have been the "shining example," was constructed in the "thorough" manner recommended by Ward.

The issue of alternative approaches to the development of the water control system was not explicitly raised in the 1949 feasibility report for the construction of the Chainat dam. In effect, however, the proposal was a revival of van der Heide's extensive approach. Although van der Heide had recognized the ultimate need for a network of drainage canals and of small distribution and drainage ditches, these features were not mentioned in the 1949 report. It was claimed that the construction of the facilities proposed (i.e., the dam at Chainat and the network of distribution canals) would bring about "perfect water control" (Thailand. RID 1949: 54).

In the early 1960's, with the basic framework of the water control system complete throughout the project area, attention shifted to improvements which would make that framework more effective. Thus the Ditches and Dikes program was initiated. This program also represented

an extensive approach to the further development of water control, with a skeleton network of ditches constructed throughout the project area. Construction of the drainage system, begun in 1965, is also following an extensive approach, with a few large canals being built throughout the area.

From this discussion it can be seen that the government has consistently followed a relatively extensive policy in the development of water control in the Greater Chao Phya area. Although the extensive-intensive issue has thus largely been settled from a historical perspective, it has recently been raised again in conjunction with proposals for the further development of the area. Some pilot projects demonstrating quite intensive approaches to further development have recently been established. There are, however, alternative approaches which would be less intensive (Small 1972 : 262-312).

Mobilization of the Farmers' Resources

Closely related to the extensive-intensive issue is the question of the role of farmers in the development of the water control system. Given the financial constraints under which government agencies must operate, this question is of considerable importance.

1. *Labor.* One method for reducing the cost to the government is to have the farmers construct the large number of small ditches required to carry the water to the individual farms. Van der Heide recommended such an approach, and it appears to have generally been the policy officially adopted by the government. Thus in the mid 1920's it was noted that despite the importance of the final distribution network, landowners and cultivators must be responsible for the construction of these works, as the expense would be too great for the government (Anonymous 1926 : 14). One implication of the discussion (in Anonymous 1926) is that farmers were not constructing these ditches.

In 1941 the concept that the farmers should provide for these facilities was incorporated into law (Thailand 1960a). In spite of the law, little construction took place. As a result, RID finally undertook the Ditches and Dikes program in the 1960's. This program does not, however, appear to have stimulated additional construction by farmers.

Furthermore, the maintenance of the ditches dug by RID (which is also a responsibility of the farmers) has been relatively poor. Efforts to mobilize the labor of farmers for the construction and maintenance of the system have thus not been very successful.

2. *Money.* A second approach to obtaining the resources of the farmers is to collect cash payments from them. This could be done in a number of ways, such as by imposing an irrigation tax or by raising land taxes. Such procedures have long been recommended. Van der Heide, for example, proposed that farmers pay a water tax of one baht per rai (6.25 baht per hectare) (van der Heide 1903:133-135). Ward also favored such a tax (Thailand. RID 1929: VII), and in addition suggested that the small ditches be constructed by RID, with the farmers being charged (under a long term credit arrangement) for the expense (Thailand. RID 1915b: 17-18). Although the Minister of Lands and Agriculture apparently accepted Ward's tax proposals, considerable opposition was encountered in other parts of the government. Among those opposed was the British Financial Advisor, Walter Williamson, who had also been strongly opposed to all of the major projects proposed by van der Heide (Ingram 1971: 196-200). In a note written in January 1916 he stated:

As regards the calculations made by the Ministry of Agriculture of the estimated increase of revenue likely to accrue from the area affected by the Prasak Irrigation Scheme, I agree in the main with the criticisms and objections offered by the Director General of Revenue and Comptroller General. The estimates are probably unduly optimistic even if an additional irrigation tax were levied as proposed, which I do not think should be done. If the fields are improved by irrigation, they can be assessed at a higher rate under the present land tax law, by being placed in a higher class, but no additional tax ought to be levied unless and until it is proved, by careful investigation, that the owners and cultivators could stand it. Even then I would not make the change for this area alone, but as part of a general revision applying to the whole Kingdom (Thailand. RID 1929: 3-4).

Ward's tax proposals were not accepted, and no charges were levied on the farmers to recover either the capital cost or the operation and maintenance costs of the water control facilities.

Although the issue of a water tax has been raised a number of times in more recent years, governmental policy has remained unchanged. Although the State Irrigation Act of 1942 authorizes the collection of an irrigation tax (Thailand 1960b), no charges have ever been made under this act. The issue was also raised in the 1949 feasibility report submitted by RID.

To amortize directly a water rate ought to be charged to the farmers benefited by the project. The tax can be enforced by clause No. 8 of the State Irrigation Act of the year 1942. The water rate should be 8% of the total construction cost per rai, of which 5% [would be] for amortization without interest and 3% for cost of annual maintenance and operation (Thailand. RID 1949 : 26).

The very next paragraph of the report made it clear that there was no intention of actually levying such charges.

It is the policy of the present Government, however, not to collect the water rate from the farmer. The investment on water control system is considered as a necessity for Social and Economic Security, such as investments for Public Education and Public Health. The repayment of loan, if any, for the construction of this project, will be derived from indirect sources of Government income, such as import duties, placed on commodities purchased from the proceeds of exports of surplus agricultural products due to this project (Thailand. RID 1949 : 26).

Again in 1961 RID discussed the water tax issue in a report requesting a loan from the IBRD for the Ditches and Dikes project.

It has been our sincere opinion that water tax ought to be levied from the irrigation water user. It is a fair taxation. The user will appreciate more of the facilities which they enjoy. They will neither abuse nor destroy irrigation canal and structure because part of the tax will be for maintenance. The more damage on structure the more cost will incur to them. The water tax for second crop will be reduced as an incentive for second crop growing (Thailand. RID 1961 : 8).

In spite of such statements, the policy of no direct charge for the water control system has been maintained. The national tax policies

which developed during the 1950's and 1960's involved not only the taxation of imports suggested in the above quotation from (Thailand. RID 1949), but also, and more importantly, the very heavy taxation of rice exports (Ingram 1971 : 243-261).

The government has thus not succeeded in mobilizing in any direct fashion either the labor or the financial resources of the farmers for the construction and the maintenance of the water control system. Viewed in historical perspective, it seems that the failure of the government to mobilize these resources has been one constraint on the development of the water control system.

Degree of Labor Intensity

In recent years there has been considerable interest in many labor surplus countries of the world regarding the extent to which the social costs of the development of public works such as water control facilities may be reduced by the utilization of labor with a low opportunity cost. In Thailand, however, the situation has generally been characterized as one of labor shortages rather than of labor surplus.

Prior to 1800, the construction of canals in the lower portion of the Central Plain was based on the use of *corvée* labor. In the first half of the 19th century, however, Rama II and Rama III began to use paid Chinese laborers for canal construction (Hubbard 1969 : 74-75).⁵ By the late 19th century, a shift to mechanical earth moving began to occur. In the development of the Rangsit area in the 1890's, the Siam Canals, Land and Irrigation Company used steam excavators for part or all of the work (Thailand. RID 1915a, vol. 3 : 48). Excavation rates quoted by the company early in the 20th century were slightly below the rates for Chinese labor (Thailand. RID 1915a, vol. 3 : 48). In 1904 the Department of Canals purchased two floating dredgers for use in the improvement of the canals in the lower part of the Central Plain (Thailand. RID 1915a, vol. 3 : 15-16). One advantage of the use of these machines was that canals did not have to be closed while work on them

5) This arrangement was profitable to the government because the tax paid by a Thai freeman to purchase his exemption from the *corvée* labor requirement was more than enough to pay for the cost of hiring a Chinese laborer to do an equivalent amount of work (Hubbard 1969 : 74).

proceeded. By 1908 the Department had purchased six such machines (Thailand. RID 1915a, vol. 3 : 26).

Construction of the projects recommended by Ward involved extensive use of machinery, as can be seen from a progress report written in 1926.

Owing to the very high cost of labour in Siam even when the works were first contemplated, it was at once evident that if the works were to be carried out at anything approaching a reasonable cost, machinery would have to be adopted extensively (Thailand. RID 1927 : 10).

The only labour available in Siam in large numbers for earthwork excavation is Chinese and as they are working in a foreign country and need to send money to their homes, they naturally demand much higher rates than those paid to local labour in most Eastern countries (Thailand. RID 1927 : 46).

In this report it is noted that the cost of excavation for the main canal of the South Pasak project would have been 1.5 baht per cubic meter if Chinese labor had been used. Mechanical excavators were purchased, and it was found that they could excavate at an operating cost of about 0.4 baht per cubic meter (Thailand. RID 1927 : 46-59). Although complete data on the fixed costs of these machines are not available, it appears that the total cost of mechanical excavation was less than 1.0 baht per cubic meter (Thailand. RID 1927 : 46-59, 197).

While it might be argued that the actual prices for labor and machinery did not correctly reflect the true social costs of these inputs, it must be recalled that the Chinese were foreigners who remitted most of their savings to China (Ingram 1971 : 204-205). Thus regardless of the theoretical marginal social cost of Chinese labor, employment of such labor under the actual conditions of an open economy would have resulted in a drain on foreign exchange.

Although the question of Chinese labor has not been so important in recent years, Thailand has never developed the large surpluses of labor that characterize some low income countries. Thailand does appear to have a considerable amount of unutilized labor in the dry season, however. Since from a national production point of view this labor

has a very low opportunity cost, it might be argued that employment of this labor could lower the social cost of construction. There are a number of factors that make such a conclusion questionable. First of all, there are real costs involved in the organization of such labor. Recruiting the workers; transporting them to the proper location; providing food and shelter for them; and supervising their work all require the use of scarce resources. Secondly, it is probably not feasible to construct certain facilities (such as the dams and headworks) on a seasonal basis. Furthermore, the use of seasonal labor for canal excavation might imply inefficient use of some items of equipment which would be either idle or under-utilized during much of the year. Finally, such an approach would probably greatly lengthen the period of construction, during which no return is earned on the investment.

It can thus be concluded that while it might be possible to use seasonal labor for canal excavation, the net effect on the total social cost of constructing the water control system cannot be determined without a detailed examination of the factors mentioned above. From the historical record it appears that no such examination has ever been made, and that the question of the utilization of dry season labor has never been seriously considered. Thus construction of the water control project in the past two decades has continued to rely heavily on the use of mechanical equipment (Thailand. RID 1961: 13-15; Thailand. RID 1949: 52-53).

Returns to the Investment in Water Control

Throughout the history of the the Greater Chao Phya project there has been considerable controversy regarding the nature and magnitude of past and future benefits resulting from the water control system. Thus while van der Heide enumerated the benefits to be expected from his proposal, others, such as the Financial Adviser, were not convinced that these schemes were important (Ingram 1971: 196-200). In part this must have been due to the fact that the proposed water control projects would not have resulted in any direct increase in public revenue.

The serious droughts of 1911 and 1912 apparently convinced many people that investment in water control would yield substantial

returns to the nation. Undoubtedly the public commitment by the King on January 1, 1913 (Thailand, RID 1915a, vol. 3 : 30) to the construction of water control facilities also reduced opposition to such development.⁶

Although proponents of water control thus obtained approval for the construction of some projects, skepticism regarding the usefulness of the projects was soon expressed. The first project was not finished until 1922 (Thailand, RID 1927 : 19), and was not brought into complete operation until 1923; however, in January 1925 an article was published in which an attempt was made to "allay to a certain extent the feeling of despondency which is undoubtedly abroad, as to the ultimate benefit to be derived by the country from the Irrigation System properly constructed and controlled" (Anonymous 1926 : 1).⁷ The author argued that more time should be given so that the effect of the system under a variety of weather conditions could be observed. Furthermore, it was noted that farmers in the Central Plain had not had previous experience with such a system, and therefore "patience must be exercised" until they acquire the necessary skills (Anonymous 1926 : 1-2).

Skepticism regarding the benefits of the project remained. In 1927 a request for 16,500,000 baht for four additional projects was made. After the matter had been referred to the Financial Council, the King was "graciously pleased to approve of a grant of Tcs. [baht] 2,500,000 for 2471 B.E. [1928] only and to express a desire to take the matter into consideration again when statistics showing benefits already accrued and estimated have been brought to His notice" (Thailand, RID 1929 : II). This resulted in the preparation of a report entitled "On the benefits which

-
- 6) This commitment was made prior to Ward's arrival, although an agreement apparently was reached in advance with the Ministry of Finance that a sum of up to 1.75 million pounds sterling could be spent for water control. The fact that the Minister of Lands and Agriculture had proposed that the government should be prepared to spend up to three million pounds suggests that the opposition in the Ministry of Finance had not completely disappeared (Thailand, RID 1915 b : II-III).
- 7) It appears that this article was written in the Royal Irrigation Department. Quite possibly the author was C.D. Gee, Adviser to the Royal Irrigation Department, whose name appears on a number of RID documents with similar phraseology.

have already accrued to the State by Irrigation Works already completed, and what benefit may be expected from Works still to be undertaken" (Thailand. RID 1929). In this report, an effort was made to show that while no direct revenue resulted to the government, the projects were successful in reducing the magnitude of crop failures (Thailand. RID 1929 : 6, 9-15).

Although the commitment of the government to the Greater Chao Phya project became much stronger after World War II, questions concerning the effectiveness of the project persisted. As new investments were made to reduce the deficiencies of the system, expectations regarding the effects of the project increased. The fact that dissatisfaction continued to be expressed is clear from the following quotation from the report of a United Nations mission to Thailand in 1968.

The Mission has assumed that the main reason for its origin arises from disappointment at the slow rate of increase in agricultural production in the Chao Phya delta in spite of the investments made to improve the water supply there (Food and Agriculture Organization 1968 : 2).

From the historical record it appears that one of the reasons for disappointment in the results of the system has been the fact that development has, to a considerable extent, proceeded on a trial and error basis. Thus in 1908 it was found that the structures which had been built to retain water in the Rangsit area hindered the rapid removal of excess water which had entered the area as a result of the disastrous flood of that year. Fearing heavy crop losses if the water level could not be lowered quickly, RID ordered that the earthen dams be cut, and that the locks be opened. The locks, which had not been built for the release of water, were severely damaged. The Department of Canals spent most of the final years of its existence repairing the damage and building additional structures to prevent a recurrence of the problem (Thailand. RID 1915a, vol. 3 : 23).

In 1922, upon the completion of the diversion dam on the Pasak river for the South Pasak Project, concern was expressed over the possibility of harmful effects to another area.

... [U]rgent representations were made that if the barrage was to be operated it was absolutely necessary to provide Klong [canal] Roeng Rang with a head regulator, not only to take full advantage of the available river supply, but also to prevent the damage that would be done to the crops at the tail of the Klong by the uncontrolled supply that would pass into it with the barrage in operation (Thailand. RID 1927 : 63).

In this case it is unclear whether the difficulty had not been foreseen, or whether it had been assumed that a proposal for another project (which included construction of this regulator) would have been approved by the time the diversion dam was completed.

Other examples of the trial and error nature of early developments can be taken from the Suphan project (Pho Phraya) in the northern Chao Phya area. Construction of the head regulator on the Suphan river at Pho Phraya was completed in October of 1925, at a time when crops both upstream and downstream from the regulator were suffering from a serious water shortage. Since the downstream area was larger, the changwat Governor ordered that the gates of the regulator be opened. This was done, but the water level in the river was too low to enter any of the downstream canals. When this was observed, orders were given to close the gates. But by that time the supply in the river was so low that the water could be headed up enough to serve only a few canals. RID officials estimated that a much larger area could have been served if the gate had not first been opened (Thailand. RID 1927:134). Two years later it was discovered that the regulator was unable to function as anticipated because of the very small amount of water coming into the Suphan river (which is a distributary of the Chao Phya). The problem was silting at the head of the Suphan river, where one to two meters of additional silt had apparently been deposited in the 14 years that had elapsed since Ward made his proposals. Simply dredging the head of the river was regarded as dangerous because of the possibility that such action might result in the main river shifting its course into the Suphan channel. To prevent this, an additional regulator at the head of the river was recommended (Thailand. RID 1929:19).

Development in this trial and error fashion was in part due to the large and hydrologically complex nature of the project area, and the resulting lack of knowledge of the exact effect that a given change would have. Financial constraints certainly also contributed to the difficulties. Important elements of projects were often modified or temporarily ignored in order to obtain financial approval. As certain aspects of the system were later found to be deficient, efforts were then made to obtain the additional resources necessary to bring about the desired improvements. In terms of the previous discussion, the extensive approach to the development of water control was to a considerable degree imposed by financial constraints, which were exacerbated by the inability to mobilize the resources of the farmers in the development of the system. Under such conditions, expectations concerning the effects of the system were probably often unrealistic.

REFERENCES

- Anonymous. 1926. *Irrigation in Siam*. (n.p. 1926. Originally published as an article in *The Record* (the Organ of the Board of Commercial Development, Thailand), No. 15, January 1925).
- Food and Agriculture Organization of the United Nations, United Nations Development Program Survey Mission for the Chao Phya Delta, Thailand. 1969. "Report to the United Nations Development Programme, 4 February to 30 April, 1968." (EA:SF/THA/68. Rome, April 30, 1968).
- Hubbard, Robert V. 1969. "The Canals of the Chao Phraya River Delta in Thailand." (MA thesis, University of Michigan, 1969 (?), draft).
- Ingram, James C. 1971. *Economic Change in Thailand 1850-1970*. (Stanford, Stanford University Press, 1971).
- International Bank for Reconstruction and Development. 1963. "The World Bank Group in Asia: A Summary of Activities." (Washington, D.C. (?), September 1963, pamphlet).
- Silcock, T.H. 1970. *The Economic Development of Thai Agriculture*. (Ithaca, New York, Cornell University Press, c. 1970).
- Small, Leslie E. 1972. "An Economic Evaluation of Water Control in the Northern Region of the Greater Chao Phya Project of Thailand." (Ph.D. thesis, Cornell University, 1972).
- Thailand. 1960a. "The Field Dykes and Ditches Act, B.E. 2484," in *Laws Concerning Irrigation*, Second edition, pp. 20-28. (Published by Royal Irrigation Department, Bangkok (?), 1960, in Thai and English).
- Thailand. 1967. "Loan Agreement (Phasom Dam Project) Between Kingdom of Thailand and International Bank for Reconstruction and Development." (September 19, 1967).
- Thailand Royal Irrigation Department. 1915a. "Project Estimate for Works of Irrigation, Drainage and Navigation to Develop the Plain of Central Siam." (Ministry of Lands and Agriculture, Bangkok, 1915, 4 vol.).
- Thailand. Royal Irrigation Department. 1915b. "Report on a Scheme for the Irrigation of so much of the Valley of the Menam Chao Bhraya as may be Possible for a Capital Outlay of One and Three Quarters Million Sterling." (Minute by H.R.H. Prince Krom Luang Rajaburi Direkridhhi. Report by Mr. T.R.J. Ward. Ministry of Lands and Agriculture, Bangkok, 1915).
- Thailand. Royal Irrigation Department. 1927. "Administration Report of the Royal Irrigation Department of Siam for the Period 2457 B.E.-2468 B.E. (1914/15-1925/26)." (Bangkok, 1927).
- Thailand. Royal Irrigation Department. 1929. "Report of the Royal Irrigation Department of Siam on the Benefits which have already accrued to the State by Irrigation works already completed, and what benefit may be expected from Works still to be undertaken." (Bangkok (?), January, B.E. 2471).

- Thailand. Royal Irrigation Department. 1949. "Report on Irrigation Drainage and Water Communication Project of Chao Phya River Plain." (Report by M.L.X. Kambhu, Director-General. Bangkok, 1949).
- Thailand. Royal Irrigation Department. 1951. "Additional Information to be included in the Revised Project Report on the Dikes and Ditches Project." (Bangkok, August 7, 1961).
- Thailand. Royal Irrigation Department. 1962. "Yanhee Multipurpose Project Bhumiphol Dam, Thailand." (Bangkok (?), 1962 (?)).
- Thailand. Royal Irrigation Department. 1963. "Water Resources Development in Thailand and Its Policy." (Report by M.L. Xujati Kambhu, Director-General. Bangkok, December 1963).
- Thailand. Royal Irrigation Department. 1964. "Nan River Project, Thailand. Multipurpose Project Irrigation, Power, Flood Control and Navigation. Feasibility Report." (Prepared by Engineering Consultants, Inc., Denver, November 1964).
- Thailand. Royal Irrigation Department. 1965. "Supplementary Report. Nan River Feasibility Report." (Bangkok, 1965).
- Thailand. Royal Irrigation Department. 1970a. "Northern Chao Phya Study." (Netherlands Engineering Consultants (NEDECO), The Hague, 1970, 3 vol.).
- Thailand. Royal Irrigation Department. 1970b. "Royal Irrigation Department." (Bangkok, September 1970).
- Thailand. Royal Irrigation Department. n.d.a. "General Information on Dry Cropping of Greater Chao Phya Project and Petchburi Project Areas in 1969-1970." (n.d., (mimeo)).
- Thailand. Royal Irrigation Department. n.d.b. "General Information on Dry Cropping in Greater Chao Phya Project and Petchburi Project for 1970-1971." (n.d., (mimeo)).
- Thompson, P.A. 1906. *Lotus Land*. (London, 1906).
- United States Bureau of Reclamation. 1955. "Report on Yanhee Project, Thailand, for Power, Flood Control, and Irrigation." (Prepared for Royal Irrigation Department, n.p., December 1955, 2 vol.).
- van der Heide, J. Homan. 1903. "General Report on Irrigation and Drainage in the Lower Menam Valley." (Report to the Ministry of Agriculture, Kingdom of Siam, Bangkok, 1903).