STORED IRRIGATION SYSTEM IN SRI LANKA WITH SOME COMPARATIVE REFERENCE IN NORTHEAST THAILAND

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I. Introduction

Irrigation has been a basic need for most of Asian agriculture. Through some kinds of artificial devices for irrigation and drainage almost all agricultural lands in Asia have achieved or have potential to achieve double or triple production comparing with non- irrigated land. In this sense Asia is a region of irrigated agriculture while irrigation in European history has not played any significant role in food production. To a great extent the history of agriculture in Asia is one of human struggles against the shortage of water supply or the floods from major rivers. Thus, irrigation and drainage systems in Asia have been developed to cope with these unfavorable situations of scarce or excessive precipitation.

II. Classification of Irrigation Systems

The important sources of irrigation are officially classified into three types, namely, river canals, tanks, and wells . This classification, though made conventionally from the view point of civil engineering, is not helpful in understanding the social and economic characteristics of irrigated agriculture in Sri Lanka and South India. Instead of the conventional classification, the present paper attempts to classify the irrigation systems in Asia theoretically into the following two types with minor variations.

(1) Perennial system:

Perennial system is developed with the use of abundant water resources in the region where unlimited supply of water is possible through large perennial rivers or sustained accumulation of rainfall and snow. Infrastructural and institutional arrangements are to ensure a constant flow of irrigation water in down- streams of main canals within the system. Such a system inevitably requires proper drainage facilities.

(2) Stored system:

In this system the maximum utilization of artificially stored water is needed because water stock itself is subject to the seasonal fluctuations of rainfall. Surface or quasi- surface water is stored as much as possible. Shallow wells with or without tubes are a part of the stored system since the supply source of them depends mostly on availability of the surface and quasi- surface water in the neighbouring area.

Apart from these two systems the deep tube- well irrigation may be an effective device to tap naturally stored water for several thousand years or much longer priod. Though the utilization of deep underground water by artisan or power tube- well has started to be explored now in the South Asian region, it has very little scope in the dry districts of Sri Lanka and South India where it is insufficient even as supplementary source of irrigation. The pin-pointing exact availability of deep underground water resources has always been difficult since the deep underground water storage depends on the geological structure which is not related to annual variations in rainfall at all. Geological sciences have not yet succeeded in devising ways and means to assess accurately the quantitative distribution of deep underground resources in general. Even after so many years of continuous surveys and researches, nobody in the world has fully reliable information about the availability of such vital resources like petroleum or natural gas. Due to these reasons we prefer to exclude the deep tube-well irrigation from the scope of the present study. This system could not be dealt with in our study until we have more exact knowledge about deep underground water resources.

Agricultural civilization based on the stored system has most highly developed in the dry parts of Sri Lanka and South India to such extent that no region in the rest of the world can compete with them. The nature of the stored irrigation system and its social implications are entirely different from those of the perennial irrigation system. Unfortunately, however, the theoretical framework of hydraulic society has been developed on the basis of large-scale irrigation works in the perennial systems like Nile, the Yellow River, the Ganges, and so on. As it is practically immpossible for an ordinary cultivator engaged in irrigated agriculture to envisage the amount of water flowing in perennial canals or big rivers, the supply of irrigation water to his field is beyond his control and his cultivation may be compelled to rely on the despotic irrigation bureaucracy.

Where irrigation water is not flow but stock in stored condition, even a common farmer has been able to estimate the amount of water available for the coming agricultural season at a glance. In fact, cultivators in the command area of the stored system in Sri Lanka and South India have organised themselves and held seasonal meetings to decide jointly the date for the inception of irrigation, the extent land for irrigated crops and the mode of waterdistribution from the stored system without any bureaucratic nor political authority. The stored system has been essentially constructed and maintained by the collective efforts of the peasant cultivators in the concerned area, and the irrigation water has been duly allocated by village organisations themselves except the cases of the highly developed stored systems like large-scale reservoir networks which are interconnected by trans-basin canals.

Compared with the perennial system, the eminent feature of water management in the stored system is indicateded in the forms of the popular participation and decentralized maintenance practices. The stored system has been used as a supplemental water supply to the major seasonal rainfall in the cultivable land. The stock of irrigation water alone is not sufficient to support main agricultural activities in most village settlements. Hence, it is almost imperative that stored system should be combined with non-irrigated cropping and animal husbandry in the region. These non-irrigated sectors may provide a kind of buffer against adverse rainfall to the catchment area of the stores system.

Thus, the development of agriculture under the stored system is quite different from that of the perennial system where every inch of arable land can be irrigated at least in theory. There must be another set of theoretical frame of reference to examine the social and economic significance of the stored system. Instead of applying the existing theory of the hydraulic society based on the perennial system we must come up with a new theory through the empirical study on the stored irrigation system.

In the light of our classification, almost all of the irrigation facilities in Sri Lanka and South India should be regarded as stored systems, and the conventionally classified structures of canals, thanks, and wells are nothing but variations in the development process of the unitary stored system. Shallow open wells extensively observed all over the state of Tamil Nadu often share the same source of irrigation water with the neighbouring tanks while the water levels of both are determined by the rainfall in the catchment area. The larger the diameter of open wells, the more water can be stored in them depending upon the availability of quasi- surface water to which the water of nearby tanks or ponds is contributory. Tanks may be regarded as a more developed form of open wells located in topographically suitable position.

III. Technological Innovations in the Stored System

Many Sri Lankan and south Indian rivers have been converted or are to be converted from the perennial system to the stored system. For example, the largest river in Sri Lanka, the Mahaveli, is no longer perennial while having been converted to the chain of tanks during the past two thousand years. The construction of several major dams during Anuradhapura period was the starting point of this conversion. After the completion of the Randenigala dam in 1988 the runoff of the Mahaveli ceased to flow at least for a few months in a year. No canal in the Mahaveli system is perennial either. In fact, some canals have been made transportation facility to convey irrigation waters from one tank to another.

The irrigation philosophy expressed by king Parakrama Bahu II in the eleventh century was nothing but the manifestation of the dream of the perfect stored system in this region. "Not even a little water that comes from rain must flow into the ocean without being made useful to man." (W. Geiger, trans, Culavansa, Part I, Colombo, 1953, p. 272). All the irrigation engineers in modern Sri Lanka are trained on the basis of the statement made by the ancient king.

The ultimate objective of the irrigation technology and water management in the region has been conceived as the attainment of the perfect stored system, which does not allow a single drop of water to be wasted either in fields nor canals. Major technological innovations created in the course of the historical development of the stored system could be summarised to five main features.

(1) The stone structure of cistern sluices to draw the irrigation water underneath the heavy earth dam or *anicut.* According to R.A.L.H. Gunawardana, (Indian Historical Review, Vol. 4, No. 2, Jan., 1978) the invention of this cistern sluice around the second century was of far-reaching social and economic significance and "may be compared with such innovations as the heavy, wheeled

plough and stirrup in European history." The massive stone structure of the cistern sluice or *anicut* might have affected the mode of temple architecture in the region. *Biso- kotuwa* in Sinhala is the local term used for both structure of cistern sluices and stupa (pagoda) in Sri Lanka.

(2) The trans- basin canal to transport irrigation water from one basin to another. Thanks to this technology the catchment ceased to be a sole water resource in the stored system of the particular basin because the trans- basin canals were made to bring the required water even from remote basins. The formation of irrigation network in the stored system has been made possible through this device.

(3) The linkage between large- scale storage tanks and small farm ponds to allocate and redistribute the scarce water resources in the region. Repeated use of the irrigation water from one place to another is aimed until the last drop of it through the series of tanks (sometimes more than 100 tanks). The micro-topographic environment in the dry districts of Sri Lanka plays a vital role for the location of tanks, ponds, open wells, link canals, paddy fields, and village settlement as well as the construction of the above trans-basin canals.

(4) The civil engineering devices for the huge earth embankment to prevent the large stored system from breaching. The magnificent earth work was done by the organised human labour alone without surveying equipment and mechanic power just as the construction of religious monuments had to require the same kind of man- power mobilization in which Buddhist *sanga* must have played a certain important role.

(5) The level- crossing canals to enable the subtle adjustment of water available among various tanks. Water brought from a canal is allowed to flow into another and taken away again to the canal of the original direction with increased or decreased quantity. This was the substitute of the modern siphon crossing device, but more useful in case of reallocation of irrigation water into different canals than the latter.

(6)These combined technological innovations led to the establishment of the irrigation network in the stored system under which irrigation and drainage were made interchangeable depending upon micro- topography. Unlike the perennial system where separate drainage canals are needed, all the water in any kind of canals is used again and again in down- streams without any distinction between irrigation and drainage. Even at the field level the drained water from one plot is utilised as irrigated water in the adjacent plot. In other words, every effort has been made to prevent any water from draining to the ocean without wastage except evapo-transpiration.

IV. Institutional Features in the Stored System

Under the stored system time factor is converted into space factor. When rainfall in a particular cultivating season is not sufficient to irrigate the entire paddy field under the command area of a tank, a meeting of all the landholders is held to decide the extent of land to be cultivated with irrigation water available in the tanks. The extent of irrigated space expands or shrinks according of the diachronic change of rainfall. If only one third of the paddy field is irrigated, all the farmers work together and share the harvest in proportion to their holdings. This customary arrangement is called *bethma* in Sinhala. On the contrary, rotational water distribution known as *warabandi* in North India is seldom practiced in Sri Lanka and South India.

The amount of water is divided in terms of time schedule in the perennial system of North India, while it is divided in terms of space in the stored system of Sri Lanka and South India. Village self- government or a union of several villages was responsible for water management. But, the British colonial administration established centralized irrigation bureaucracy like the Public Works Department or Irrigation Department. This inheritance of colonial irrigation bureaucracy has badly discouraged and seriously damaged the autonomous water management institutions in Sri Lanka and South India even after the political independence.

Traditional communal practices of *kudi-maramath* and organizations for water management like *madaghu adaippan* ceased to exist in the dry region of South Asia. Instead of traditional water management, water cess was levied for the service of PWD or Irrigation Department. Any many settlement schemes have been taken up by the irrigation bureaucracy. At the same time unauthorized water use both in old tank- based villages and newly created colonization projects started to increase. Nowadays, illegitimate water users caused the chronic problem of uncertain supply of irrigation water in the stored system.

It should be pointed out here that the grave agrarian problem attributed to the stored system is the inherent propensity to the excessive exploitation of water resources which are subject to the wide fluctuation of annual rainfalls. The more water from the catchment area stored in the tank system, the less run- off there will be in the river. The increased water in the stored system tends to encourage the creation of extended paddy fields in the command area of the basin. The excess water of tanks in some basins of Sri Lanka and South India is diverted to the areas where paddy cultivation suffers from shortage of water. This practice itself is, no doubt, rational reaction of enthusiastic cultivators in the basin. As a result of it, the expansion of irrigated agriculture is overwhelmingly promoted in contrast to dry crops and animal husbandry, and the society becomes more dependent on the irrigation system.

The extended paddy cultivation which sustains more population than the non- irrigated agriculture in the same area can be regarded as an indicator of the economic prosperity as long as water supply is assured by the irrigation facilities. This tendency for the increasing dependency upon irrigation agriculture, however, poses some grave problems as the yield of wet crops is very susceptible to the climatic change of environment. Unlike the most part of Southeast Asia, the rainfall by monsoons is variable and fluctuates widely in the dry districts of South Asia. The precipitation in some districts during frequent drought condition amounts to less than 30 percent of a good season .

Under the conditions where all available water on the land surface is collected and stored in the tank system, over- developed irrigation practices tend to attempt the maximum exploitation of resources, neglecting non- irrigated agriculture. If the drought conditions continue to prevail for several consecutive seasons, the water in the stored system is not sufficient for the expanded paddy cultivation and compels the increased population to desert the irrigated agriculture in search of an alternative livelihood. The historical records show that repeated famines in the dry zones of Sri Lanka and South India have been caused by the result of the dangerous over- exploitation in the stored system. This may be one of the reasons behind the very high mobility of agricultural population to other regions as migrant labourers.

A certain degree of waste must be allowed in the stored system to keep up the optimal exploitation of water resources and the balanced development between the irrigated agriculture and non- irrigated agriculture, particularly animal husbandry. The irrigation bureaucracy as well as farmers under the stored system is apt to overlook the optimum point and embark on the way to the excessive development, missing the neglecting significance of the vital need to waste. In this manner, the both apices of the Mahaveli stored system in Sri Lanka and the Kaveri system in South India are almost reaching the stage of the over-development.

The extensive rural electrification in 1960s and 70s in the northern villages made it economical to draw more water from wells by the pump sets than by draught animals. A tremendous endeavour has been made to increase the extent of irrigated lands through the electric power in many dry villages adjoining to the Mahaveli system. Those villagers who can afford to install one or two electric pump sets are liable to convert *chena* (non- irrigated land) into *kumbru* (irrigated land).

In the recent past the agricultural development in the upper strata of the village community in the dry zones of Tamil Nadu meant the expansion of irrigated crops by the construction of a little deeper open wells with motor pump sets. As mentioned earlier, these open wells around irrigation tanks are sharing the same source of water. In order to obtain the assured water supply under the same micro- topography some well- to- do villagers have begun to dig their new wells slightly deeper and wider than the neighbouring ones. In defense of the existing wells the neighbouring farmers are sometimes forced to deepen their wells too.

In the near future dry villages will also be in danger of the excessive exploitation of irrigation sources as a result of the competition from deepening and widening wells. It is reported that the water level of some wells for domestic use like bathing, washing, cooking, etc., decreased considerably during the recent agricultural seasons.

V. Sustainable Water Use of *Isan* Agriculture

The well developed micro- topographic landscapes of the Northeast Thailand called *Isan* are akin to the dry zone of Sri Lanka as well as her climate with wide fluctuation of monsoon rainfalls. Just like the Northeast Sri Lanka, the Korat plateau at an elevation of 100- 200 metres above sea level accounts for large portion of Isan and 90 percent of the total area is below the 500 metres contour. It is not difficult to convert some depressed parts of land surface to artificial ponds for water management, and historically many ponds have been actually created to store water for human use.

But, one can seldom find stored irrigation in the entire *Isan* compared with Sri Lanka in spite of rich cultural interaction between both countries in the long history. For example, a glimpse of *Phra Ruang* Dam at the West of old Sukhothai city reminds one of common features for irrigation observed at many reservoirs in the dry zone of Sri Lanka though the landscapes are not so similar to Sri Lanka as the case of *Isan*. Many of artificially excavated ponds in *Isan* have not been meant for irrigation purposes but for domestic water use, inland fishery, cattle breeding and so forth.

The archaeological excavation at Ban Chiang reveals that the cultural sequence represents more than 4000 continuous human settlement and the earliest known site in Southeast Asia with indigenous bronze and iron manufacture. People should have led comparatively peaceful life for extraordinary long period since the evidence indicating the existence of raiding, warfare and ruling elites seems to be absent at Ban Chiang (Surapol Natapintu, *Ban Chiang; a world heritage in Thailand*).

The basic characteristics of the *Isan* history is the co- existence of different cultures with the complex succession of multi- ethnic elements into sustainable human life including Mon, Tai- Siam Dvaravati, Khmer, Lao etc. More than 100 stone architectures established during the Khmer Empire at the places like Muang Phimai and Prasat Phanom Rung suggest that the bulk of the technological work done for the construction of Hindu temples could have been utilized for the large scale stored irrigation system if increased production were really needed in the society even before 11th century.

The stone structure called *somasutra* (a set of stones where lustral can flow out)lies at the most sacred part in the sanctum sanctorum of Hindu temples of Khmer ruins and connected to the moat of the compound under the temple floor through water course made of sand rock. The technology needed for the construction of the *somasutra* is, more or less, similar to the stone structure of cistern sluices to draw the irrigation water underneath the heavy earth dam. Yet, Huge *barai* reservoirs in front of Khmer temples were not equipped with this device, indicating that water of it was not intended for agricultural use.

It seems that people in *Isan* chose the way which led to the sustainable development rather than the way to the catastrophe by the excessive exploitation of water resources in the region. At present income per capita in *Isan* people with longest historical heritage is much lower than the average income in Thailand, not to mention the income level of Bangkok people, but the same heritage may point to the assured sustainability. The question is how people in *Isan* came to realise the significance of sustainability in the long course of agricultural development. One of the reasons for this remarkable choice may remain the absence of non- irrigated food crops in Isan such as wheat, barley, sorghum, millet and so forth. Studies in this direction must be conducted in future.

VI. Concluding Remarks

Second thought may be needed for the implementation of tank modernization project in Sri Lanka South India if they lead to the reduction of re- use ratio of irrigation water through the land consolidation, concrete lining of channels, the separation of irrigation and drainage channels in place of a plot to plot irrigation. These devices require more water to the same extend of paddy- field, thus exploiting water resources more violently than in pre- modernization conditions. Therefore, the significance of stored irrigation system must be studied even for the practical development projects.

Certain irrigation engineers in Japan conceive that Kukai, a Buddhist monk in 8th century brought the stored irrigation system from China where South Asian experience had been conveyed along with Buddhist scriptures. This could be cited as the result of the technical transfer between different cultures. More intimate inter- cultural relations will be revealed if comparative studies on agricultural civilizations in Southeast Asia are carried out by interdisciplinary scholars. The reasons why such prosperous agricultural civilizations as Angkor wat and Borobudur collapsed may suggest the vulnerability of the stored irrigation system. The sudden decline of ancient and medieval civilizations based on the stored system should be re- examined in terms of broader perspective of technological transfer among Asian people.