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Hydrography of Rice Land in the Vietnamese Part of the Mekong Delta

by

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Introduction

Traditional rice culture in the Mekong delta is characterized, in short, by its perfect adaptation of the growing system to the natural environment, especially to physiographic and hydrographic environment. It is signified by such facts as (i) adjustment of the growing season to the coming of natural water, (ii) selection of rice varieties to be adopted, (iii) peculiar method of cultivation like a double transplanting method, and (iv) various growing practices as planting by digging holes with use of a stick, slashing weeds, non-ploughing and non-harrowing, etc. Hence, the author feels it necessary to describe the water regime of the paddy fields at the present stage on which the traditional system of rice growing is based, and to analyze the possibility of improving the water conditions for the future possible patterns of agriculture in the delta.

This paper aims at providing connecting links between Takaya's presentation of the physiographic framework of the Vietnamese part of the Mekong delta (Takaya, 1974)[1] and Fukui's analysis of the present structure of rice culture in the same area (Fukui, 1974),[2] by describing the present situation of hydrogrphy. Takaya's physiographic subdivisions of the delta are used as hydrographic subunits without making any modification because topography and water conditions are closely correlated. The author tries to predict the future possible patterns of water control and utilization in the referred area from solely a standpoint of hydrography and hydro-technics. Basing on this background, it is expected that Fukui will be able to prospect future agriculture in the delta.

1. Hydrographic Setting

Two factors play key roles in determining the hydrographic conditions of the paddy fields in the delta; they are seasonal patterns of rainfall and topography.

Monthly rainfall patterns at some selected rain-gauge stations are shown in Fig. 1. The rainy season in the delta commences in May and lasts until November. The deltaic area seems to be subdivided into four subregions with respect to the amount of annual rainfall as shown by isohyets in Fig. 2, although whole delta area falls in the Group V climatic region according to Kyuma's classification (Kyuma, 1972).[3] In general, the year round

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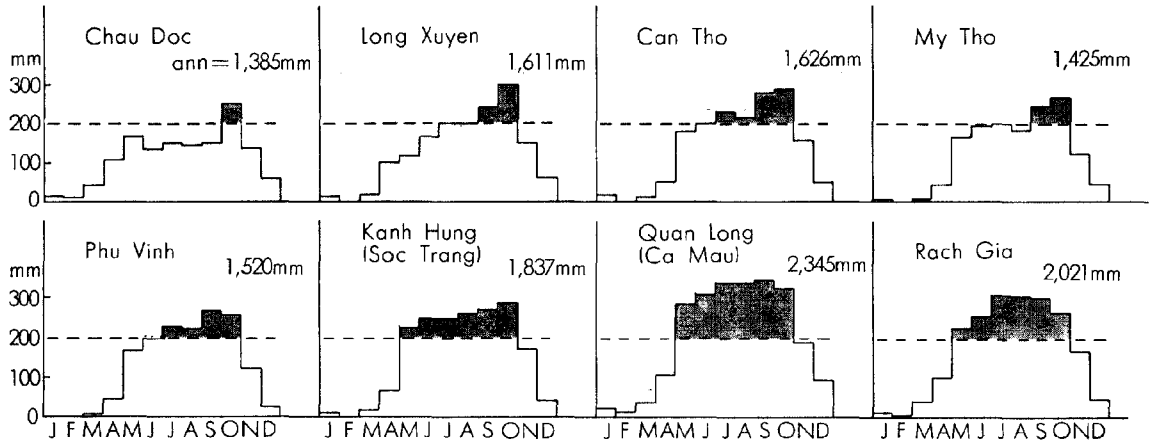

Fig. 1 Average monthly rainfall at some selected rain-gauge stations. (Refer to Fig. 2 for the location of each station.)

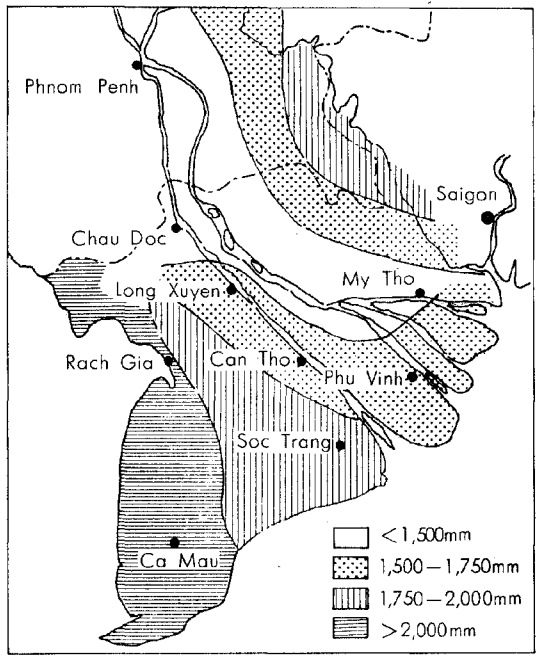

Fig. 2 Average annual rainfall in the Mekong delta

patterns of available monthly rainfall show relatively flat distribution of rainfall over the rainy months from May through October, with average monthly precipitation of ca. 200—300 mm. There is little or no evidence of the "dry spell" in July and August, which is a common incident in continental Southeast Asian countries like Thailand and Cambodia. Especially in south-western part of the delta rainfall for the period between May and October is just about enough to make secure successful rainfed rice growing in normal years. In any case, the alternation of dry and wet seasons is very clear as long as the annual pattern of rainfall is concerned.

But, attention should be paid to the fact that the alternation of dry and wet condition is

more pronounced in elevated land, and less pronounced in lowland. This is solely because of the drainability of water in terms of surface as well as underground water which is completely governed by topography. For example, in the elevated part of the delta such as levees and sand bars associated with backswamps, Trans-Bassac Plate, and higher parts of Coastal Complex, the alternation of total desiccation in the dry season and total submergence in the latter part of the rainy season takes place. However, adversely in lowlands such as Broad Depression and Lagoonal Swale close to the coastal zone, soils are perennially wet, or at least groundwater table is very shallow even in the midst of the dry season.

Although the original water regime of water channels is as defined by natural climatic and physiographic characters of the delta, present water conditions are more or less controlled by human activities that have been carved on the land, which are exemplified by such facilities as the famous canal networks of the Mekong delta and coastal dikes and gates. On the other hand water conditions in paddy field are totally governed by the natural environmental conditions because water in paddy fields is completely isolated from that of creeks and it relies on rainfall *in-situ*. The role of man-made facilities seem not very significant to rice growing, if not negligible.

2. Water Regime of Fields for Traditional Rice Culture

The water conditions in the delta so far as the water regime in rivers and channels is concerned, have been investigated for years by various institutions and many results thereof have been reported elsewhere, (ECAFE, 1960–73[4]; SOGREAH, 1964–66[5]; Netherlands Delta Development Team, 1974[6]). In this section, the present condition of water in paddy fields, not hydrology of water channels, will be described on each physiographic region given by Takaya. The description in this part is qualitative rather than quantitative as it is solely an outcome of the field trip undertaken for the period of two months from July to August, 1974.

Trans-Bassac Plate

This very flat and slightly elevated extension of land parches out completely during the latter half of the dry season, from February through April. This is proven by the fact that there exists no perennial grass except in some spotty or linear shaped marshes. As the rainy season proceeds, the soil becomes wet but not submerged under water until the end of August. Maximum inundation of ca. 100 cm takes Place usually in late October to November. This inundation is caused by local rainfall of which run-off is choked up by high water level of elsewhere surrounding the plate. Flooding of river water plays minor role in causing the moderate inundation as there is no big river entering into this area, and as ground elevation is higher than the adjoining physiographic regions by ca. 50–70 cm. Direction of drainage is towards the Gulf of Thailand.

This area is differentiated from the adjoining Flood Plain by its remarkable system of big canal networks as shown in Fig. 4. However, note that the density of the canal networks in this area seems still not high enough for water to spread to the paddy fields, though the canal networks are indispensable for the provision of living compounds and

domestic water, as well as for water communication. This vast stretch of land could not have been accessed and reclaimed into paddy area if it had not been for this canal networks. For further discussion of the historical development of the rice cultivation in this area, Fukui's paper should be referred.

The only feasible way of rice growing in this area is by broadcast method because no water is available for preparing fields for transplanting in the early part of the rainy season.

Flood Plain

Drainability in the dry season is fairly good because this area has ubiquitous big natural water channels with sizable tidal range of ca. 30–70 cm. The result is the total desiccation of soil in the latter half of the dry season, which is indicated by non-existence of perennial grasses except in some lowlying swales. Submergence takes place from the beginning of September immediately followed after by the sharp rising of water level caused by flooding from Trans-Bassac Plate and by choking up of rivers that empty themselves into the Mekong and the Bassac. Flooding is further aggravated by the coming of flood water which topples the banks of the Mekong and the Bassac far up-streams. Note that Flood Plain is a routeway of the highest flood as the name itself describes the phenomenon. Maximum inundation depth increases up to 2 m, in some swales up to 4 m, within a month in September or in October (Xuan, 1974).[7] Only the floating rice is able to survive in this particular condition—the abrupt rising of water level in the later stage of the rainy season.

River flow is abundant even in the midst of the dry season, being induced by the wide range of tidal fluctuation of water in the major rivers. Rivers and creeks of this area flow back and forth semi-diurnally according to the tide-induced level of water in the main rivers, thus providing year round fresh water to the living compounds and fruit gardens along river courses. But note that even one drop of river water never falls in the paddy fields behind the orchard area in the earlier stage of the rainy season when the rice plants demand much water. The available water were usable all through the year if there had been small ditches and water pumps, and if farmers had ever felt a need of irrigation for the conventional cultivation of single crop of floating rice.

Modern Delta

Topography of Modern Delta is characterized by the mosaic combination of small scale levees and backswamps with tidal creeks. Note here that the elevation of the lowest ground is as low as the MSL. The water conditions along a cross section of this area are schematically illustrated in Fig. 3. Micro-relief is reflected by the minute mosaics of dry and wet portions in the dry season. At the first rain in May, the water table appears to the ground surface in the lowest portion, or at least soil moisture there is moist enough so that farmers are ready to start to transplant rice seedlings, usually by digging holes using a special stick (cok) in which a few seedlings are planted. As the rainy season proceeds the steady rainfall and its local runoff help extend the inundated portions gradually to the relatively elevated area until the day of full moon of seventh lunar month (middle August in a solar calender) when river water begins to flow in paddy area by gravity through small natural creeks or through man-made ditches, if any. By this time the first transplanting

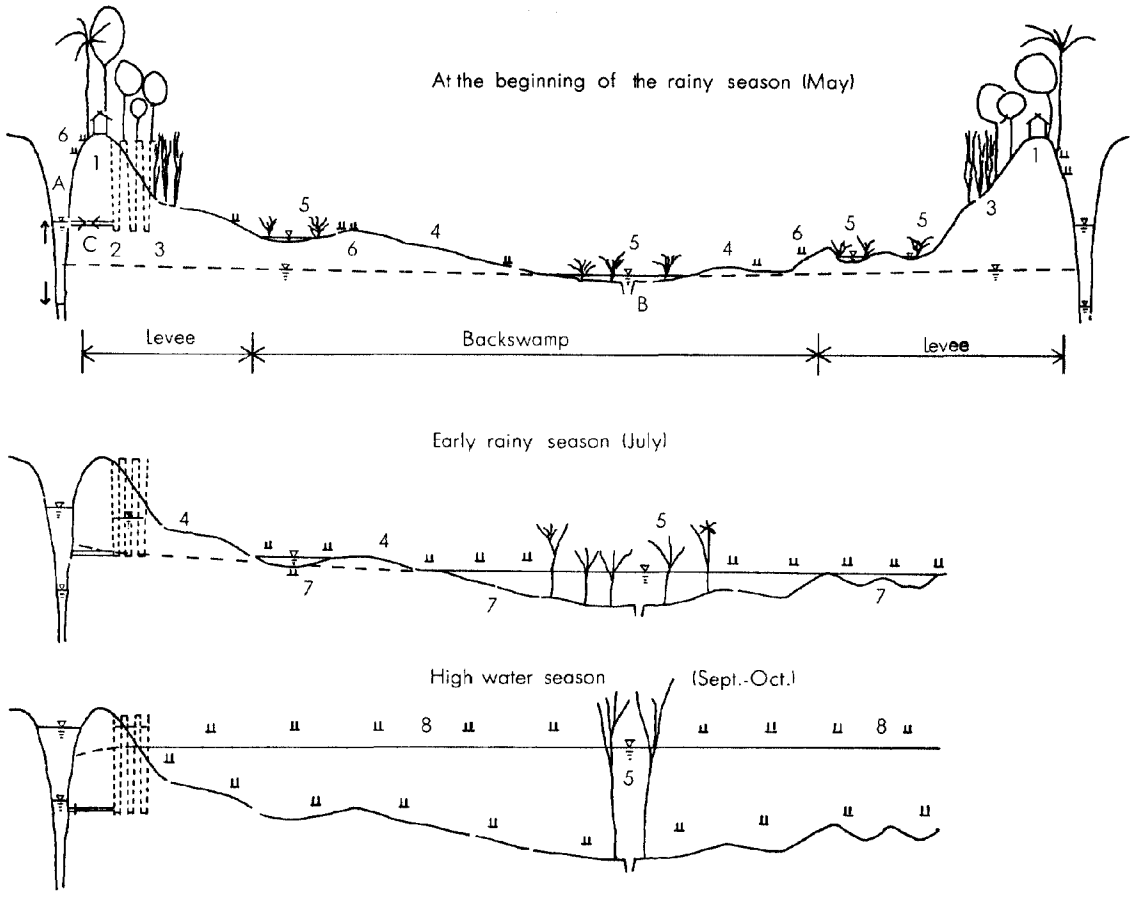

Fig. 3 Schematic illustration of a typical cross section of Modern Delta showing land use pattern and water conditions

1 House compound with ever green trees
2 Fruit garden on raised beds (poldered lot)
3 Sugarcane, soybean, etc.
4 Vacant land with grass of annual species
5 Swamp with grass of perennial species
6 Nursery beds
7 First transplanted rice
8 Second transplanted rice
A Small river with a significant tidal range
B Natural drainage channel
C A connecting ditch between river and fruit garden

of the double transplanting method is over. Approximately one fifth of land of low-middle elevation is occupied by the first transplanted rice. Waiting for a time when all the area is submerged under water in late August to September, farmers begin to pull out the plants of the first transplanting and retransplant them on whole of the land under deep water.

The highest elevated land close to a levee seldom inundates since the drainability there is fair. This high land, back of the house compounds is used for fruit garden, or in some

cases for sugarcane patches, etc. which are usually planted for home consumption. They are planted on raised beds of ca. 100 cm high. There, the river water goes in and back from the deep furrows between the raised beds surrounded by high dikes semi-diurnally according to the tidal fluctuation of river water.

It seems not very difficult for farmers to try to use the river water for irrigation by making use of small man-made ditches with intake structures and low-lift pump. This type of small scale structures and earth works can be constructed by the efforts of single farmer or by a group of farmers concerned. So far, this has not been carried out, but rather, the farmers have chosen to try to adapt their way of rice growing to the natural water regime as being exemplified by the double transplanting method.

Coastal Complex

Coastal Complex is composed of three sub-landunits, Raised Sand Ridge, Coastal Flat and Lagoonal Swale. Most rice fields are located in the latter two. Water regime is not identical in these two areas.

Coastal Flat: Rice growing must be practiced totally under the rainfed condition because of some adverse factors. First, river density is extremely low (see Fig. 4), and secondly, river water is often salty in the early periods of the growing season. In addition, it is necessary to take much care not to get salt damage which may be caused by the accumulation of fossil salt in the surface layer. The fossil salt is carried to the surface layer by upward capillary action of soil water when soil moisture is deficient. Rice growing period is carefully determined so as to cope with these difficulties inherent to this area. Farmers wait the transplanting until the end of July or early August when precedent rainfall has suppressed the accumulated salt, and when a threat of water deficiency due to a break of the rainy season (dry spell) may have been over; and harvest by the end of December when the surface ponded water may diminish. Farmers usually build high bunds surrounding their paddy parcels, and maintain them carefully so that they can keep as much water as possible.

Lagoonal Swale: This is the elongated shallow swales parallel to the coast line and along the tidal river courses. There is a constant threat of sea water intrusion during the low flow season since the ground surface is usually lower than MSL. River water near by has to be prevented from entering the paddy fields by constructing high dikes of ca. 70–90 cm high. Naturally farmers are compelled to grow rice depending solely on the rainfall *in-situ*. Drainability is fair because of significant tidal range of the rivers and canals.

Rainfall amount is abundant, and its pattern of monthly distribution is quite favorable especially in the coastal zone, but at present only a single crop of rice is bearly possible because of the unfavorable conditions of water and salt in the Coastal Complex.

Broad Depression

Broad Depression is, potentially, a swamp subject to perennial inundation. Rice growing may be possible at any time of the year in terms of the availability of water. However, the rice growing season is limited to the high water season in order to cope with such adverse factors as (i) toxicity caused by the acid-sulfate soils, (ii) salt water intrusion, though in limited areas far down south to the sea coast, and close to major rivers, (iii) vigorous growth of weeds of the perennial special species of *scirpus* and *cyperus*. Farmers

slash down weeds with a long scythe, then transplant gigantic seedlings in deep water usually without carrying out ploughing. This is practiced in late August when the saline or acidic toxicity has been diluted by abundant fresh water available from precipitation and run-off from the adjoining areas, or flooding from rivers.

Drainability is unfavorable except for some areas close to the major river courses where sizable tidal fluctuation of creek water level is expected. Thus, they have to harvest rice plants in deep water, even in January or February. The geometorical patterns of canal networks shown in Fig. 4 are primarily for drainage of excess inundation. The canal system is a prerequisite for the extension of paddy areas, providing a means of three-fold purpose; (i) drainage, (ii) water communication, and (iii) living sites on its banks.

3. Future Prospect of Irrigation and Drainage

3-1 Changing Phase of Rice Culture

Significant change of rice cultivation has been, and now is taking place since past eight years when the new high yielding varieties of rice such as IR varieties had been introduced in the delta. Vietnamese call the IR rice varieties as *Than Nong* (TN). This changing phase cannot be overlooked. The new experience of growing new rice was initiated in Modern Delta, then swiftly disseminated in the other two physiographic regions, eg. Flood Plain and the marginal parts of Broad Depression.

In Modern Delta, the adoption of TN rice was quite easy without making any sacrifice of the traditional pattern of rice growing—the double transplanting. The vacant fields of middle elevation that are waiting for the second transplanting in the early half of the rainy season have been devoted to the planting of TN rice. TN rice fields are subject to neither drying up nor deep inundation during the growing season from June through August. Supplementary irrigation by low-lift pumps may be carried out if necessary—once soon after the transplanting usually followed by two to three times in the growing period, and at most five times. Water is usable whenever and wherever necessary only if a small movable pump is available, as perennial creeks and temporarily ponded swales are ubiquitous. No sacrifice on the side of the traditional practices—double transplanting method—is needed. As the consequence of partial practice already undertaken, land use ratio under rice has risen to 1.3–1.7 in most cases.

In Flood Plain, unlike in Modern Delta, the supply of water for TN rice is totally dependent on an artificial irrigation by pumping. This is because of the deficit of soil moisture during the early half of the rainy season as described in the earlier section. Once farmers had pumps, farmers would be able to grow two crops of TN rice, one in the early rainy season, from June through August, and the other after the recession of flood from November through February. This practice is, however, limited to the narrow elongated areas along natural rivers and creeks, and man-made canals of having perennial flow where pumping-up is economically feasible all year round. The width of the area seldom exceeds 300–500 m. Some big farmers with entrepreneurship have appeared among well to do farmers in particular area near Chau Doc, who provide the other farmers with

irrigation ditch systems and pumped-up water with reasonable water charge. In other places of delta, some farmers bought larger pumps for specific use of irrigation purpose, while the farmers in Modern Delta use smaller "sampan" pumps because the irrigation there is only supplemental.

In Broad Depression, TN rice has been introduced easily in some marginal zones close to major river courses where water control is not very difficult once the fields be protected by strong dikes, and where the soil toxicity is of no problem. Water deficiency is of no trouble, because this area is primarily a perennial swamp. River water runs into the fields by gravity when high tide reaches, and drains at the time of low tide. Some investment are required for building dikes, bunds and simple ditch systems with intake structures. Once these facilities are provided, no more cost of operation is needed. Cropping patterns currently practiced in this area are at first TN rice for the period from June through August and then conventional local rice from late August to January or February. The double transplanting method has been adopted in some cases in order to make the room for the first planting of TN rice.

3-2 Water Resources

Traditional rice growing has been entirely dependent on rainfall which is sometimes so erratic as described in the previous section. Little effort, if not nil, has been made to take in, convey and to distribute river water to fields in order to supplement the erratic rainfall. But instead, farmers have tried to adapt their way of rice growing practices to the given hydrographic conditions by adjusting the growing season, the variety and the planting method, etc. Farmers have tried to invest in the agronomic know-how rather than in civil works. The only exception to this is the case of the garden culture along the narrow levees facing the perennial river flow in Flood Plain and in Modern Delta where tremendous earth works have been invested by the efforts of individual farmers.

Resources of water in the delta are abundant and readily usable. The low flow of the Mekong and the Bassac is not less than 2,000 cusecs, and fortunately it is almost evenly distributed to many distributaries (Netherlands Delta Development Team, 1974)[6]. In Vietnamese part of the delta most rivers and even small creeks are often perennial thanks to the strong tidal influences. Tide induced flow of water keep up the quality of water favorable, except of course, for salinity problem. And especially in the low lying areas of the delta tidal range in river channels of ca. 30–120 cm provides water users with easy means of intaking and out-draining water. Why not get the maximum benefit from this tide induced river flow? It is readily available almost anywhere if we can have some divices of water control, and if surface water is ever required for the supplemental irrigation to the paddy fields.

A map showing the river and canal networks, the availability of perennial flow and the salt water intrusion is given in Fig. 4.

3-3 Possible Types of Water Control and Utilization

As described in the earlier section, the current trend of change in rice culture seems to be accelerated further in near future. Thus the possibility of using the surface water, and not soil moisture given by rainfall alone, will need to be further considered. In view of this

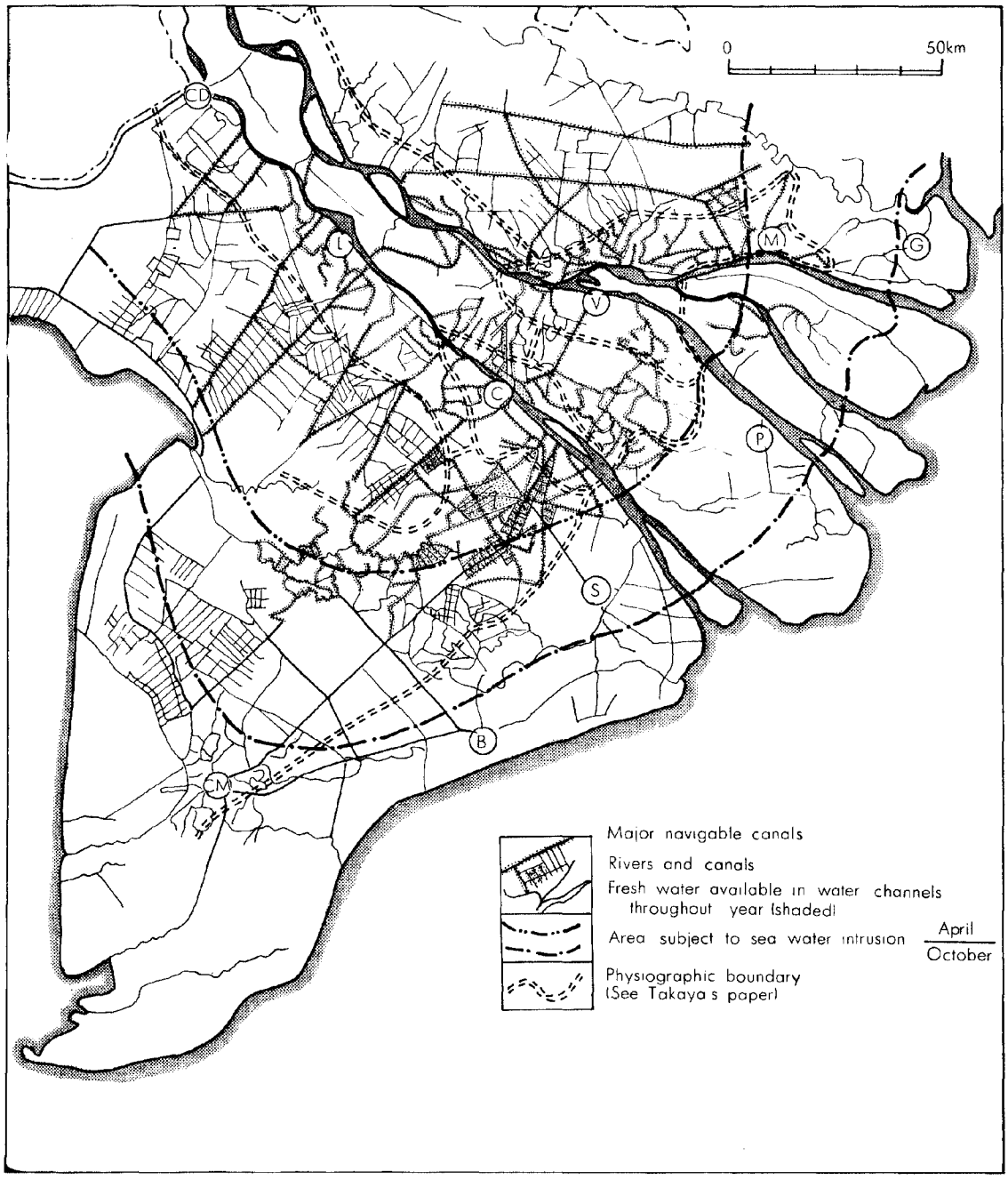

Fig. 4 The Mekong delta: rivers and canals, availability of perennial flow, and salt water intrusion. (For names of major cities shown here, see Takaya's paper.)

projection, the author tries to figure out possible types of water control and utilization in the delta for the provision of a sound base on the favorable agricultural reformation.

The case this author concerns in this part is that no big project like Pamong dam and Stung Treng dam projects is provided in the upper reaches of the Mekong river. That is, "without case" is considered here.

Flood Plain

It will not be possible, or at least economically not feasible, to control the mighty flood completely in this area. The rice culture in the area will be categorized into two types; one is the conventional floating rice cultivation with no modification of the water conditions, and the other is the growing of two TN rice crops per year prior to and after the high flood season. In the latter case, rice growing must be totally dependent on pumped-up water, and leaving the land vacant during the high flood season. Note that the water resources are readily available throughout the year. A high-lift pump would be required in Sand Bar region, but a low-lift pump of 10 HP would suffice to supply water to 10 ha downstream from Long Xuyen.

The area of two TN rice will be restricted to relatively narrow stretches of ca. 300 m along existing perennial natural water courses unless artificial irrigation canals ramified from existing big rivers be excavated. And the two TN rice area will also be studied by its profitability. It is determined by comparison of the profitability among various alternatives, such as (i) 2 TN minus costs of fuel and other minor earth works, and (ii) 1 floating rice with negligible cost plus fish raising in the rice fields. With my analysis, the alternative (i) looks more attractive.

The type of water utilization in Flood Plain is thus characterized as "pumping irrigation in low water season".

Trans-Bassac Plate

What is needed as a trigger for the future agricultural upheaval may be canal networks that enable the distribution of the perennial flow to wider areas of the Plate. If the canal networks are sufficiently dense water needs not be taken in the fields by gravity. Farmers will surely make use of that perennially available water reserved in the canals by pumping-up as far as availability of the water is guaranteed, and if an artificial irrigation is proved to be profitable. Sizable acreage of narrow strips along canals, ca. 300 m wide, may be turned out to be transplanted two TN rice area as flooding is of no severe problem here. Main canal system stretching in NE-SW direction branching off the Bassac at Chau Doc, and E-W direction which ramifies at upstream of Long Xuyen would be required. Such relatively big construction of main canal systems will require the investment on a governmental basis. In short, future prospect of this area is characterized by a phase of "canal networked flatland".

Physical limit to the extension of the dry season's water use, however, is placed by the maximum allowable extraction of the low flow without aggravating the sea water intrusion downstream. Note that the overextraction may cause a terrible expansion of salt contaminated areas bacause the hydraulic gradients of rivers of the lower reaches are extremely low. The maximum allowable rate of extraction should thus be determined with the highest possible care.

Modern Delta

A perfect control of irrigation and drainage will be attained by enpoldering relatively small patches of land, 2–5 ha, and by facilitating minor water distribution systems with structures of intake gates and check up weirs. In this way, use of land becomes possible

all year round, since the perennial flow of ubiquitous creeks with a significant tidal range helps operation of the water use system. There in the polders, fruit trees will be planted in relatively higher portions close to levees, and rice in middle to lower portions. Growing of two to three crops of TN rice per year is not difficult if a small pump is provided. Certain diversification of crops and the maximum effective utilization of land can be expected as the consequence of this type of water control, thus the future picture of this area may be called as the "poldered garden area".

Note that the modification of the area demands only a moderate investment in earth works which is manageable by the efforts of individual farmers or by a group of small number of farmers. Poldered garden areas are now being extended continuously to the leveeic portions of Modern Delta as well as of Flood Plain in order to expand orchards.

Coastal Complex

In Coastal Flat, one of the possible ways of improving the water conditions would be the introduction of sufficient amount of fresh water from far upstream near Can Tho or My Tho by gigantic canal system. This is technically feasible, but its economic feasibility is doubtful because the estimated initial investment required for the facilities amounts to a tremendous figure. Therefore, people in the large part of this huge flatland may have to keep on practicing the conventional rain-fed single cropping of rice of improved higher yielding varieties. Introduction of tree crops of salt and drought tolerant such as cashiewnuts may be worthy of study at least in some relatively elevated parts of the area.

In Lagoonal Swale, hydrographic conditions can be impoved in the same way as in Broad Depression once salt water intrusion is prevented by coastal dikes and gates.

Broad Depression

This area is, as mentioned in the earlier section, subject to perennial inundation. Thus, it has a latent potentiality of providing the most suitable fields for rice cultivation all through the year once the excess water is controlled by constructing polder systems associated with drainage canal networks. Drainability will be fairly good even during the high water period provided that huge outlets of water to the sea are constructed, because one can make good use of the high tidal range in this area.

Nevertheless, note again that the modification of the original hydrography will be feasible only in the marginal parts of the area adjoining to Modern Delta, Plate or Coastal Complex where a natural retarding basin for water can be furnished in back of them. It is of no use trying to drain all the water in Broad Depression whose original environment is a great swamp. In the central part of it, the volume of water to be thrown in the high water period is too huge, and the tidal range there is almost negligible to be effectively used for drainage.

In the main part of the area, especially where the soil suitability for paddy growing is proved to be unfavorable, fish raising would better be considered rather than trying to completely modify this area's characteristic conditions of water.

Summary

Vietnamese part of the Mekong delta is a wet terrain, being signified by the plentiful monsoonal rainfall with even distribution over the rainy months, and by low lying topography. The delta is, however, subdivided into two parts with respect to the hydrographic conditions, in which the alternation of dry and wet cycles are more pronounced in one region, and less significant in the other. These two classes are solely determined by physiography of the area. Trans-Bassac Plate, Flood Plain and Coastal Flat comprise the former region, and Modern Delta, Broad Depression and Lagoonal Swale belong to the latter category.

A perfect adaptation of the rice growing methods to the given hydrographic conditions is the character that defines the rice culture of the delta. Rice growing does not rely on

Table 1 Correlation chart of physiography, hydrography, present rice culture and potential development of the Vietnamese part of the Mekong delta

Physiography	Hydrography				Rice Culture	Potential Development
	dry season	early rainy season	high water period	drainability		
Trans-Bassac Plate	completely desiccated	moist	moderately-deeply inundated	fair-poor	Newly developed broadcast	Canal networked flatland
Flood Plain	dry	moist-inundated	deeply-very deeply inundated	fair	Traditional floating	Pumping irrigation in low water season
Modern Delta	mosaic of dry & wet	mosaic of wet & moderately ponded	mosaic of wet, shallowy ponded, and deeply inundated	mosaic of fair & poor	Double transplanted	Poldered garden area
Coastal Flat	dry	moist-shallowy ponded	wet-shallowy ponded	fair	Traditional single transplanted	Improved rain-fed rice
Lagoonal Swale	wet	moderately ponded	moderately-deeply inundated	poor-fair	Newly developed single transplanted	Poldered swale with sea water protection
Broad Depression	potentially inundated	moderately inundated	moderately-deeply inundated	poor-fair		Poldered lowland & fish raising marsh

the river water, if not at all, but it depends more on rainfall and its localized run-off which is controlled by micro-relief. At the present stage, abundant flow of rivers, creeks and canals which are often perennial being induced by the significant tidal fluctuation of water level in the sea and in the major rivers, are not playing the major role in supplying sufficient water for rice plants at their critical periods, although they are readily usable. However, the river water will have to be tapped to meet the requirement of water for TN rice which is rapidly extending its acreage as the early rainy season's crop as well as the dry season's crop. The possible types of water control and utilization are illustrated in Table 1, in view of giving the favorable conditions to the extended TN rice cultivation in the delta. The characteristics of the present hydrography in the delta are also summarized in the same Table in corresponding to the physiography and the possible types of water control.

The most parts of the modification of the hydrographic conditions in the area can be achieved by the efforts of individual farmers and of communal level. The government will be required to participate in building major water works that are a prerequisite of those efforts made by communal human powers.

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