INDIGENOUS IRRIGATION SYSTEMS ALONG THE ULU TRIANG AND TWO TRIBUTARY RIVER VALLEYS IN THE DISTRICT OF JELEBU (NEGRI SEMBILAN)

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1970/71

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PREFACE

This Graduation Exercise is a study of indigenous irrigation systems along the Ulu Triang and two tributary river valleys in the district of Jelebu (Negri Sembilan).

For two and a half months materials were gathered from diverse sources. The first month was spent getting materials from official documents and files in the Drainage and Irrigation Department (Seremban) and its Headquarters (Kuala Lumpur), the State Secretariat (Seremban), the National Archives and the University of Malaya Library in Kuala Lumpur. There was no trace of Public Works Department files before 1932 in its store in Seremban. This was rather unfortunate because the Department was in charge of irrigation before 1932. The Department's personnels explained that the documents were probably destroyed under Departmental regulations or were lost during the Second World War. The writer also had discussions with the Negri Sembilan Drainage and Irrigation Department Engineer and Technicians.

Another month was spent in the field. The writer interviewed 28 padi cultivators along the Ulu Triang, Gargu and Petasih rivers using a crude form of area sampling. There was some difficulty in finding people who remembered the water-wheel system of irrigation. A minor problem was the units of measurement used in these areas e.g. 'hasta', 'depa' and 'jari' (see Appendix 1). Most of the rice cultiva-

tors did not understand the meaning of an inch, a foot or a yard. However the interview, which was done in the vernacular language, encountered no major difficulty.

The existence of a functioning waterwheel at Kg. Jambul Lapan (Kuala Pilah District) was a great help in writing this Exercise. A few non-indigenous dams e.g. the "drop-plank dams" used in the Gargu valley were omitted from the study of indigenous irrigation systems.

ACKNOWLEDGEMENTS

The writer is indebted to the active co-operation of the people living along the Gangu, Petasih and Ulu Triang rivers, without which this Exercise will be impossible.

The writer also wish to thank the staffs of the Drainage and Irrigation Department (Seremban), the State Secretariat (Seremban), the Drainage and Irrigation Department Headquarters and the National Archives (Kuala Lumpur) for their assistance in getting official documents and files on this topic.

Grateful acknowledgement is made to Tunku Shamsul Bahrain for his guidance in the writing of this Exercise.

CHAPTER I

INTRODUCTION

The objective in this work is to deal with the broad features of the indigenous irrigation systems used in three rivers in Jelebu viz. the Gargu, Petasih and Ulu Triang Rivers, and to consider their relation to the physical environment and to the social organization of the area.

The area itself is the most isolated district in the State of Negri Sembilan. It is very hilly and it is drained by the Triang river and its tributaries.

The peasant economy of Jelebu District is based on rice, rubber and fruit cultivation. Rice is grown along the narrow river valleys and it is mainly for subsistence. Rubber provides a supplementary source of income for the peasants who are mainly Malays. The indigenous irrigation systems play an important role because the peasants depend to a large extent on wet rice cultivation.

Irrigation is necessary because weed in the rice field can only be controlled by standing river.[1] The depth of the water in each rice field is between three to six inches generally depending

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1 Drainage and Irrigation Department Manual (Government Printer) Kuala Lumpur 1959 P. 89.

'on the state of growth.' [1] When the grain is ripening, the water is drained off.

Finally, irrigation is necessary because the water levels of the rivers in Jelebu are generally lower than the elevations of the rice fields. In view of this there is need to carry the water to the rice fields. Thus the functions of indigenous irrigation systems are to either raise the water-level of the river so that water can flow into the rice field or to act as media for raising water to irrigate the rice fields.

In the Gargu, Petasih and Ulu Triang River valleys rainfall has a strong influence on the various indigenous irrigation systems. Drought is rare, but the problem is to ensure regularity in water supply because of the imperfections of the irrigation systems e.g. a flood may sweep away a brushwood dam. Rainfall is evenly distributed throughout the year although there are slight increases in March, April and May (see Table 1). The rice planting cycle which begins in June is probably to take advantage of the increase of river discharge in that period. The peasants refer to this as the "Naik Ayer" (i.e. increase in river discharge) stage. However 'seasonal variations in climate are not so marked as to make cultivation outside the season impossible.' [2]

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1 Report of the Drainage and Irrigation Department for the years 1952, 1953, 1954. (Government Printer) Kuala Lumpur, 1955. P. 8.

2 Swift M.G. 'Malay Peasant Society in Jelebu" Athlone Press Inc. (New York) 1965. P. 39.

MONTHLY RAINFALL FOR JELEBU DISTRICT
BETWEEN 1931 - 1954. (IN INCHES)

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
MEAN MONTHLY RAINFALL	5.7	4.3	6.8	8.0	6.3	2.2	3.6	3.4	5.0	6.4	7.8	8.2*

TABLE: 1
SOURCE: HYDROLOGICAL

LOCATION OF STATION:
JELEBU DISTRICT HOSPITAL

DATA 1879 - 1958. DRAINAGE &
IRRIGATION DEPARTMENT
FEDERATION OF MALAYA.

GOVERNMENT PRESS (KUALA LUMPUR)
1961. Pp. 133 - 134.

*AVERAGE FOR 19 YEARS.

MEAN MONTHLY RAINFALL OF JELEBU DISTRICT
1913 - 1918

JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
3.34	2.81	6.17	6.52	5.97	3.53	2.94	4.67	6.14	7.63	8.00	6.43

TABLE: 2

SOURCE: GRIST D.H. "WET PADI PLANTING IN NEGRI SEMBILAN" DEPARTMENT OF AGRICULTURE BULLETIN NO. 33 (KUALA LUMPUR) 1922. P. 7.

CHAPTER 2

FORMS OF INDIGENOUS IRRIGATION SYSTEMS

Along the Ulu Triang, Petasih and Gargu river valleys, three forms of indigenous irrigation systems are recognized.

They are:

(i) the utilization of spring ("anak ayer");

(ii) the use of brushwood dam ("empangan kayu"); and

(iii) waterwheel ("kinchir").

The first form of irrigation is confined only to areas which do not have a river frontage i.e. these areas are located between the hills and the rice fields which have a river frontage. A spring is derived from water that has originally infiltrated into the ground which later emerges through natural opening to the surface. Since the discharge is unusually small, only one or a few can utilize this water supply. However areas utilizing this source of water supply are small and isolated.

On the other hand, brushwood dam is usually a structure which is built across a river to raise the water level and divert the flow of water from the river into artificial water channels ("bendar") where "a continuous ..... supply of water is then distributed by gravity from 'petak' to 'petak' throughout the area." [1] In some parts

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1 Report of the Drainage and Irrigation Department for the years 1952, 1953, 1954 (Government Printer) Kuala Lumpur, 1955. P. 10.

of Negri Sembilan, brushwood dams had been known to 'span rivers over 100 feet in width.' [1] However in the Cargu and Petasih valleys the brushwood dams are usually about ten feet in length. At normal times the rivers are about three feet wide.

Finally, the third form of irrigation is the use of water-wheel. It is introduced ' to supply the higher areas which cannot be irrigated easily from the brushwood dams.' [2]

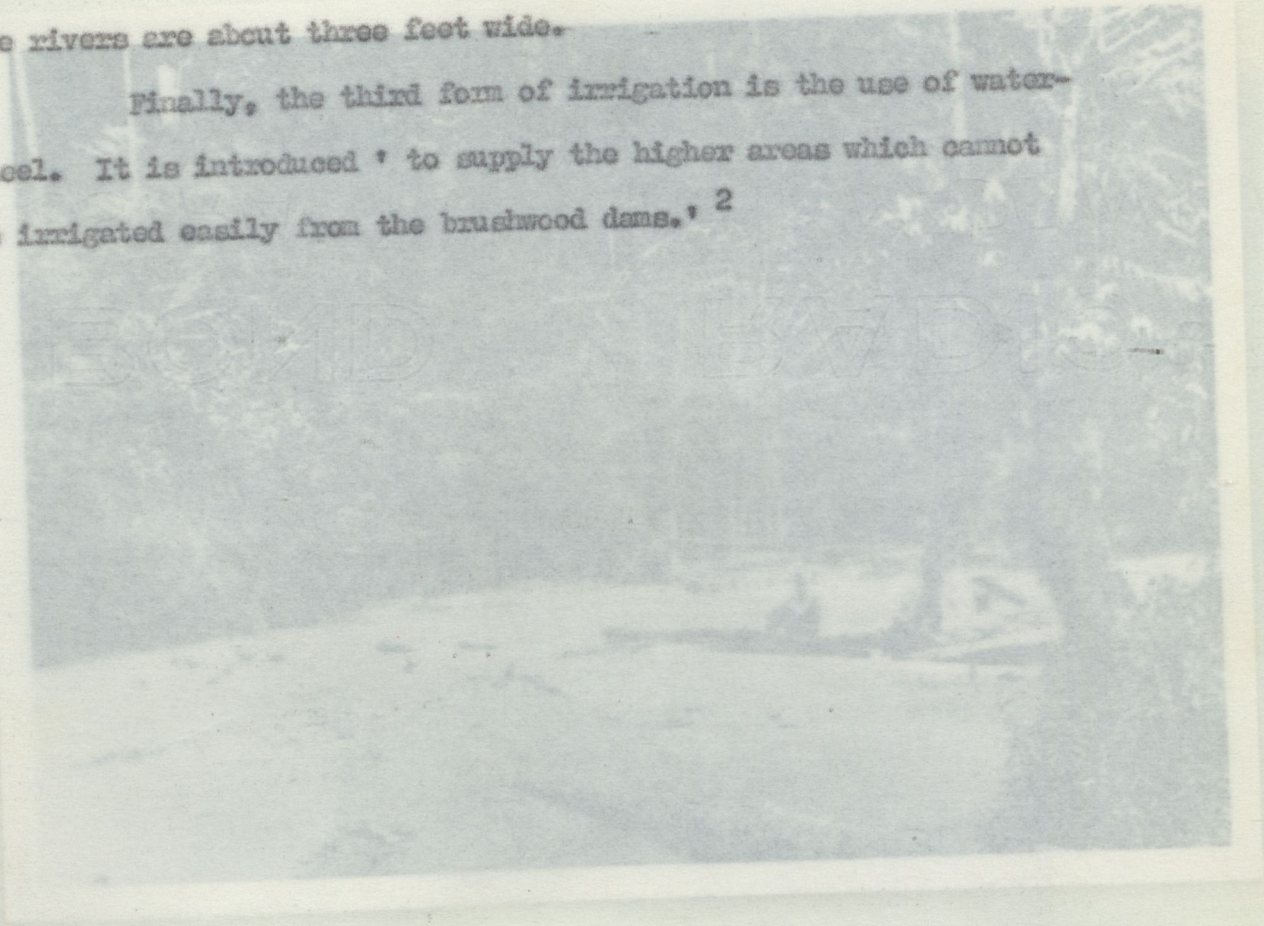

Plate 1

Source courtesy of National Archives of Malaysia

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1 Report of the Drainage and Irrigation Department for the years 1952, 1953, 1954 (Government Printer) Kuala Lumpur, 1955. P. 99

2 Drainage and Irrigation Department Manual (Government Printer) Kuala Lumpur. 1959. P. V

A WATERWHEEL IN NEGRI SEMBILAN (CIRCA. 1908)

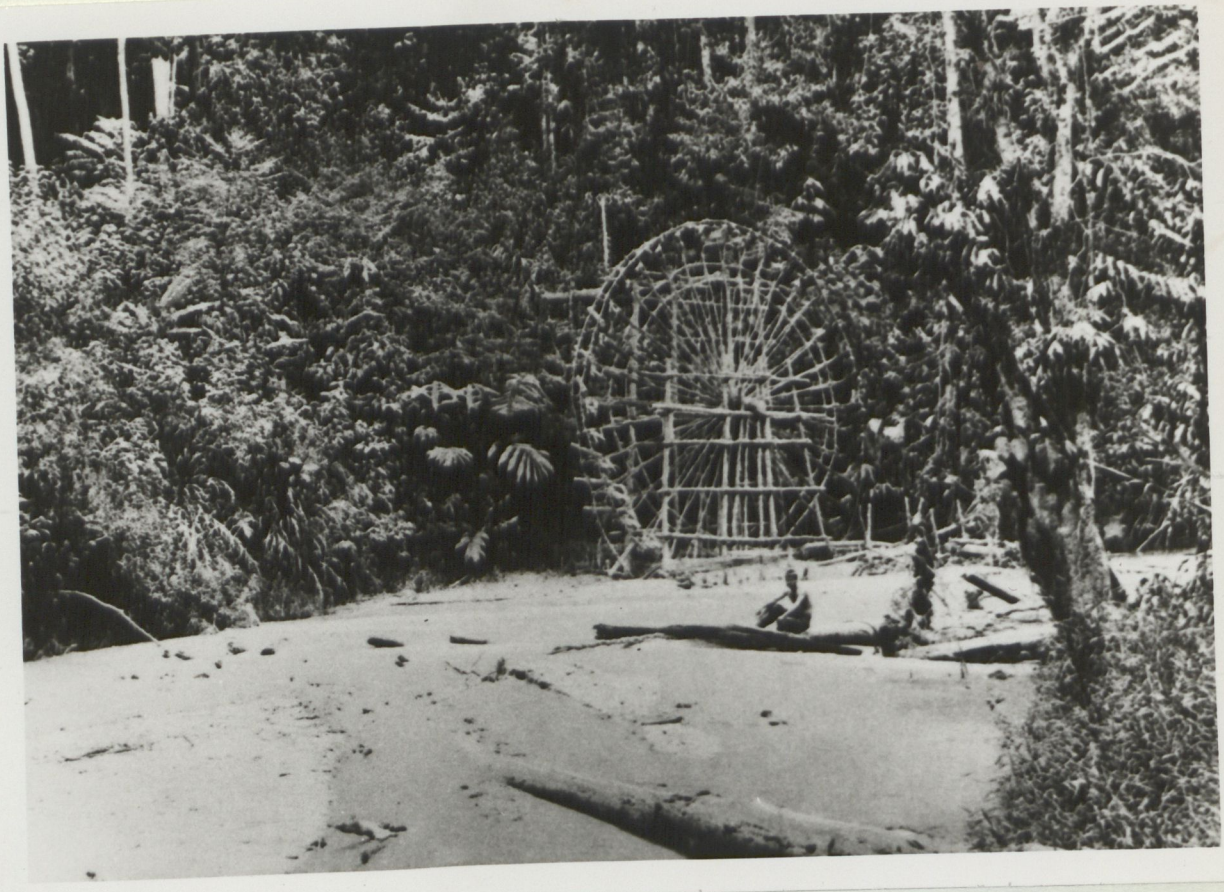

Plate: 1

Source courtesy of National Archives of Malaysia

A WATERWHEEL IN THE PADANG HIGHLANDS (WEST SUMATRA)
LOCATED IN THE MIDDLE OF A RIVER (CIRCA. 1916)

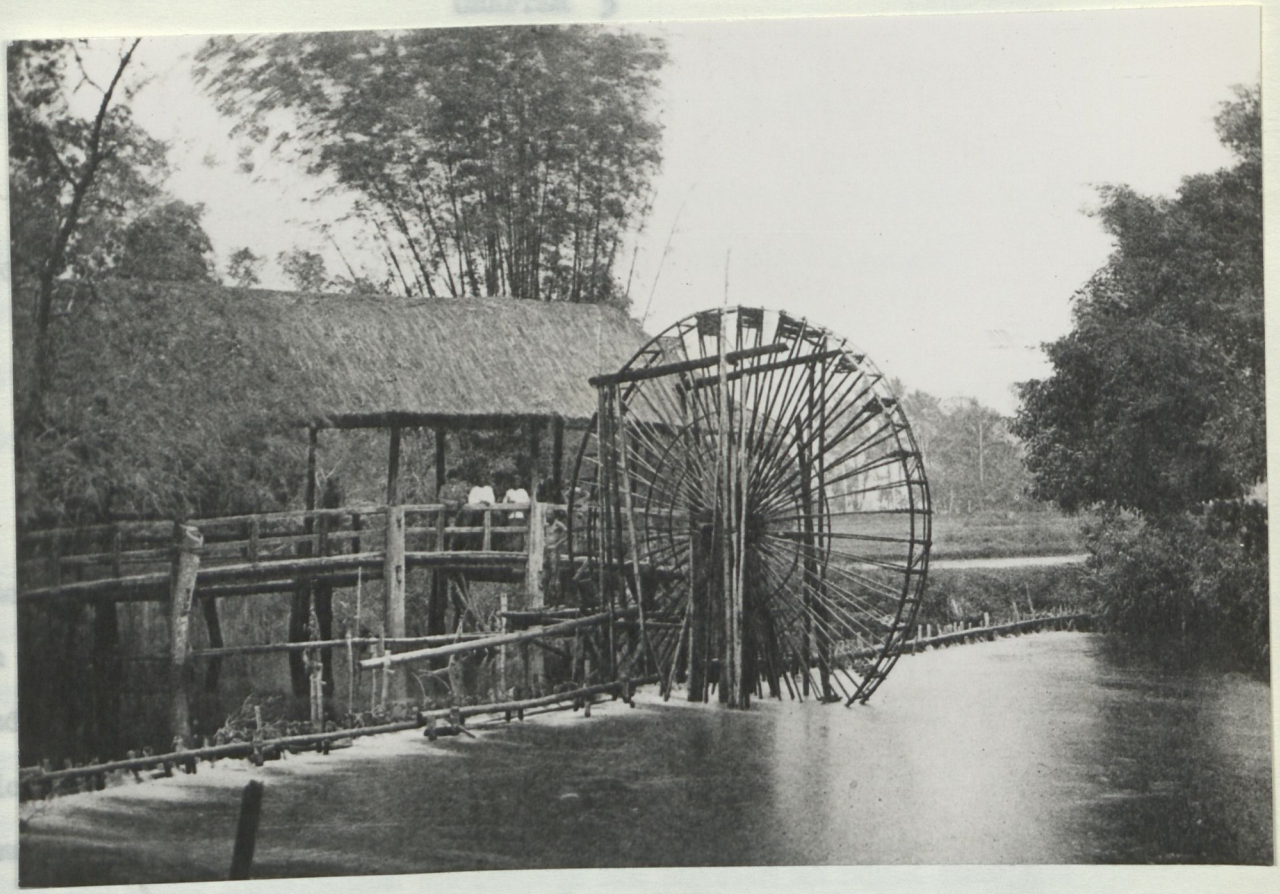

Plate: 2

Source: Leidenkerker C. Land en Volk Van Sumatra
N.V. Boekhandel en Drukkerij Voorheen
E.J. Brill (Leiden) 1916. Opposite P. 202

CHAPTER 3

ORIGIN OF INDIGENOUS IRRIGATION SYSTEMS

Irrigation as practised by the indigenous population is an old phenomena. The more important methods used in Jelebu are:

(i) the utilization of spring ("anak ayer");

(ii) the use of brushwood dam ("empangan kayu"); and

(iii) waterwheel ("kinchir")

The first two irrigation systems probably originated during the Indianized period of settlement i.e. between 500 A.D. to 1500 A.D. In this period the lowland landscape of the Malay Peninsular probably underwent a transformation from dry rice cultivation to that of wet rice which needed irrigation. Evidently, none of the peasants knew how it originated. They had learnt the techniques of constructing the various irrigation systems, from their parents.

The earliest mention of brushwood dams in Jelebu was in an official document of 1907.[1] No written informations were available concerning brushwood dam in Jelebu prior to 1907.

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1 'Report on the Jelebu District for the year 1907' in the Supplement to the Negri Sembilan Government Gazette Federated Malay States Printing Office, Kuala Lumpur 1908. P. 4.

On the other hand, waterwheels were officially mentioned in 1904.[1] In about 1908 a photograph of a waterwheel was taken in Negri Sembilan (see Plate 1). When this photograph is compared to a photograph of a waterwheel taken in 1969 (For instance see Plate 5) there is no significant difference.

Although it cannot be stated exactly when the waterwheel was first introduced into Negri Sembilan, it has probably been 'in use for over 200 years.'[2] It is probably reasonable to assume that the waterwheel was introduced into Negeri Sembilan by Minangkabau immigrants from West Sumatra. This assumption is based on three major factors:

Although that system of irrigation is also found in other parts of Asia but in the Malay archipelago the use of waterwheel is limited to a few areas viz. West Sumatra and Negeri Sembilan.[3] In other parts of the Malay archipelago, different forms of indigenous irrigation systems are used. Secondly, Negeri Sembilan Malays claim to be the descendents of Minangkabaus of West Sumatra. It is possible that the early Minangkabau immigrants who settled in Negri Sembilan brought with them the skill involved in building waterwheel. Finally, when the waterwheels of Negeri Sembilan are compared to those in West

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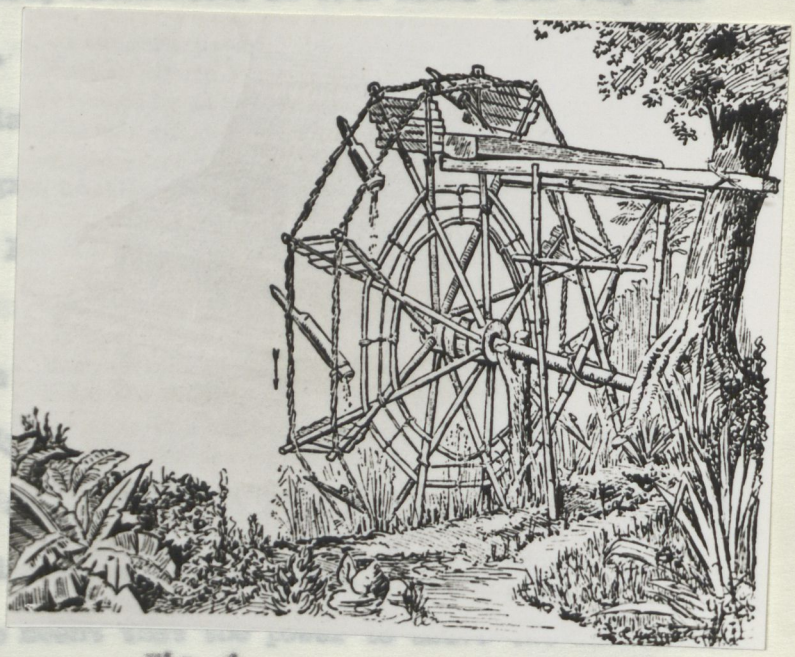
1 'Report of the Jelebu District for the year 1904' in the Supplement to the Negri Sembilan Government Gazette. Federated Malay States Printing Office (Kuala Lumpur) 1905. P. 6.

2 Drainage and Irrigation Department Manual Government Printer (Kuala Lumpur) 1959. P. V.

3 Fisher (in his book "South-East Asia") noted that 'the Minangkabau ... have a complicated system of irrigation which makes use of waterwheels' P. 283.

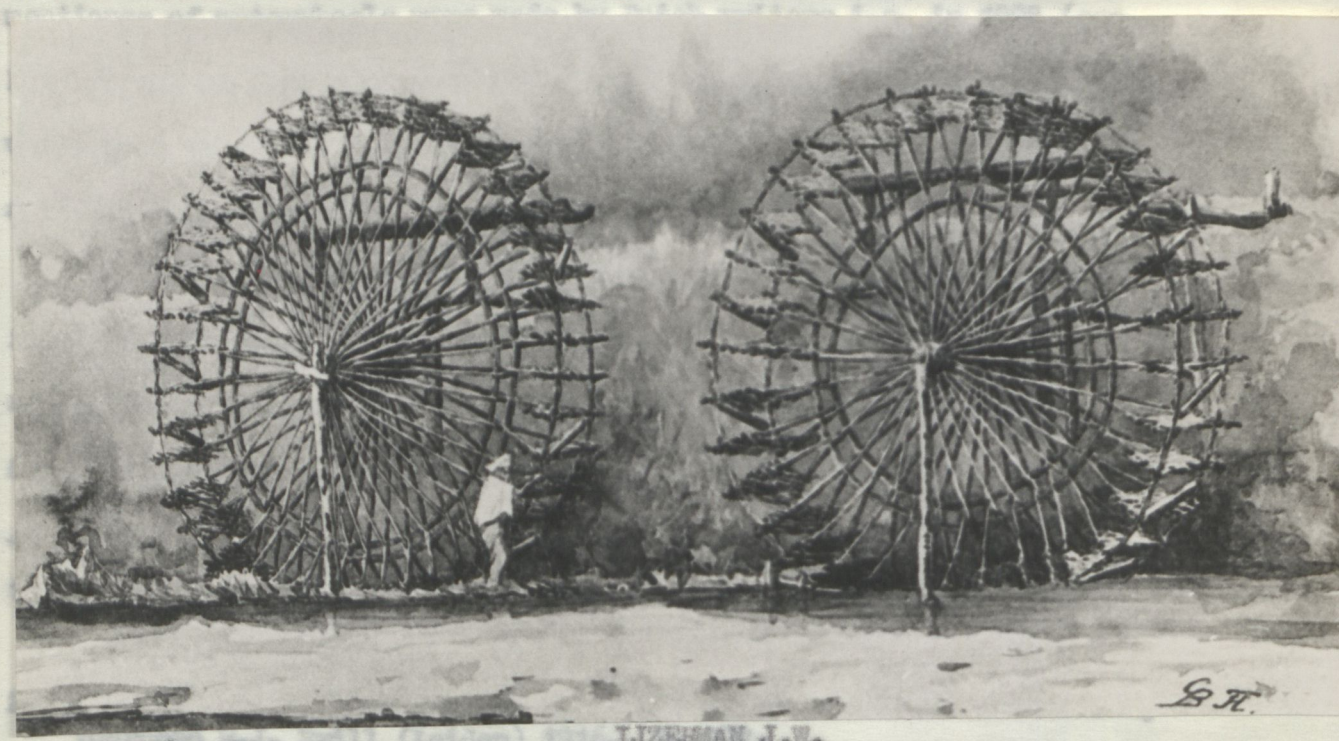
AN UNDERSHOT WATERWHEEL IN OPERATION NEAR SI-LAGO IN THE PADANG HIGHLANDS (WEST SUMATRA). CIRCA 1861



Source: Journal of Thomas Otho Travers 1813-1820 Ed. John Bastin (Govt. Printer) Singapore 1960 P. 163

Fig. 1

Waterwheels in the Padang Highlands. Circa 1895



IJZERMAN J.W.

Fig. 2

Source: Dwars Door Sumatra Van Padang naar Sink Kolff. C. & Co. (Batavia) 1895. Opposite P. 224.

Sumatra there are a number of similarities in respect of function, structure and site. In both areas the waterwheel was used for irrigation. In term of structure, waterwheels in both areas show very few differences (Compare Fig. 1 and 2 with plates 1 and 5). The sites of waterwheels too are similar in both the Minangkabau highlands (or Padang highlands) and Negri Sembilan. They are located either in the middle of the river (see Plate 2) or by the side of the river (see Plate 1 and Fig. 1).

Several western writers had observed the use of waterwheel in West Sumatra. As early as the beginning of the nineteenth century Captain Salmond observed an undershot wheel being used for raising water to irrigate the padi fields at Ulu Lebar in the Padang Highlands. [1] By undershot he meant that the power to drive the waterwheel was derived from the body of water directed at its base. Later, two mentiones of waterwheels were made by Dutch writers i.e. in 1895 (see Fig. 2) and in 1916 (see Plate 2). It is interesting to note that the waterwheel is called 'kintjir air' in Sumatra [2] and also 'kinchir ayer' in Negri Sembilan.

It is possible that the waterwheel system of irrigation is found only in Negri Sembilan because padi planting is carried out in narrow inland valleys while in other parts of West Malaysia rice is grown in the wide flood plain where "water supply depends on the over-

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1 'Captain Salmond's Journey across Sumatra' in the Journal of Thomas O tho Travers 1813-18120. Editor John Bastin (Government Printer) Singapore 1960. P. 164.

2. Loikenkerker C. Land en Volk Van Sumatra NV Boekhandel en Drukkerij Voorheen E.J. Brill (Leiden) 1916. P. 202.

flow of the banks of the rivers during the ..... rainy seasons." [1]

In Jelebu district, the physical environment influences the form of irrigation system to be used. For instance the rice cultivators in the Gargu valley, who are recent Minangkabau immigrants, may possess the skills of constructing a waterwheel but local physical factors e.g. an extremely low discharge, discourage the use of the waterwheel. Consequently the brushwood dam system of irrigation is adopted by rice cultivators in the Gargu valley.

Finally indigenous technology is capable of improving the waterwheel system of irrigation. For instance a waterwheel is able to irrigate padi fields both on sides of the river (see Plate 3).

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1 Jack H.W. "Rice in Malaya" in Malayan Agricultural Journal Vol. XI (January - December 1923) Huxley Palmer and Co. Ltd., Kuala Lumpur 1924. P. 107.

A waterwheel constructed to supply water on both sides of the river. (Circa 1922)

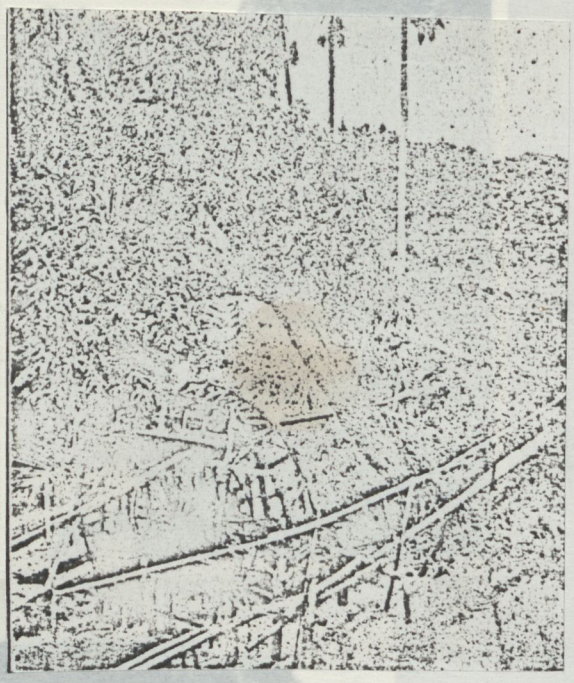


Plate: 3

Source: Grist D.H. "Wet Padi Planting in Negri Sembilan." Department of Agriculture Bulletin No. 33 Kuala Lumpur. 1922

Photographs of a waterwheel (1969)

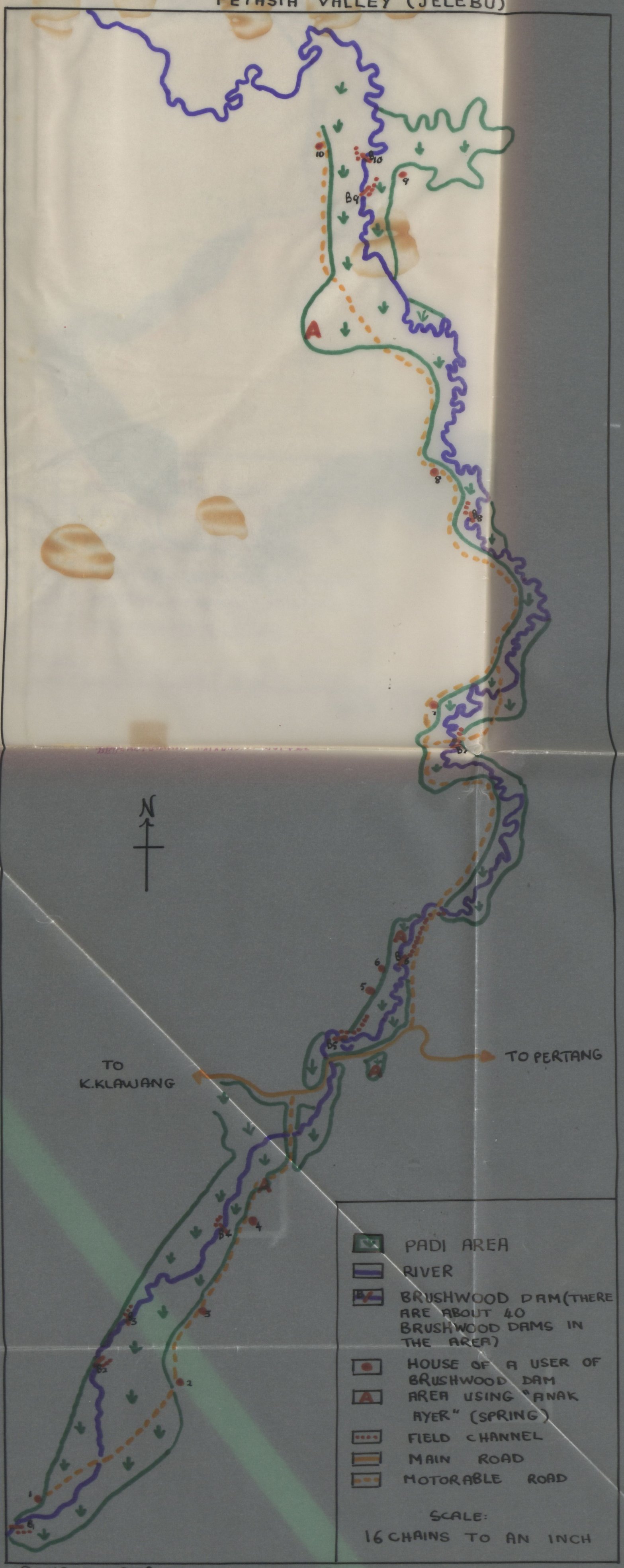
Plate 4

Plate 5

(Location: Kg. Jambul Lapan,
Kuala Pilah District)

Plate 6

MAP OF PADI AREAS IN THE PETASIH VALLEY (JELEBU)



SOURCE: DISTRICT OFFICE -JELEBU.

GENERAL PLAN OF G.GARGU SHOWING PADI GROWING AREAS

SOURCE: DISTRICT OFFI -TELEBU

CHAPTER 4

CONSTRUCTION OF INDIGENOUS IRRIGATION SYSTEMS

The construction of indigenous irrigation systems follows padi planting schedules as the objective is to irrigate a single crop of padi grown in that agricultural season. The rice cultivators have to construct the irrigation systems according to their skills and experiences.

Utilization of Spring ("anak ayer")

To ensure optimum utilization of spring, its original course is diverted by blocking the channel with stones, pieces of wood or making a new water course (see Plate 8). In this way water from the 'anak ayer' at the foot of the hill flows into each of the rice plots ("petak"). Generally one person is involved as the task of diverting the flow of the 'anak ayer' is light. The water consequently flow from one "petak" to another "petak" by gravity. Thus the construction of this system of irrigation is relatively individualistic although one "anak ayer" may serve one or a few padi farmers.

Construction of brushwood dam

In the construction of a brushwood dam the site is an important factor. It will determine whether water will flow in the required direction or whether the brushwood dam will be able to command or dominate the ricefields from a superior height.

A Typical Brushwood Dam

Plate 7

Arecanut tree trunk used as water channel from a spring ("Anak Ayer")

Plate 8

(Location: Petasih area, over abandoned river meander 50 yards south of B_5)

Brushwood dams along Petaeih River

Sketches of location of dams

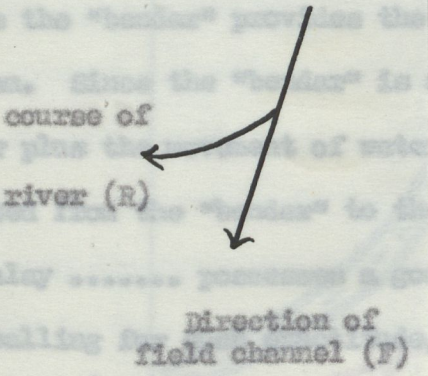


Plate 9 (Location: B_3)

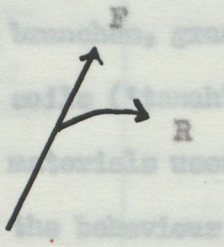


Plate 10 (Location: B_5)

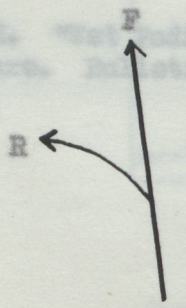


Plate 11 (Location: B_7)

A Generalized Pattern of Site of Brushwood Dam

(a) Before Brushwood dam is built

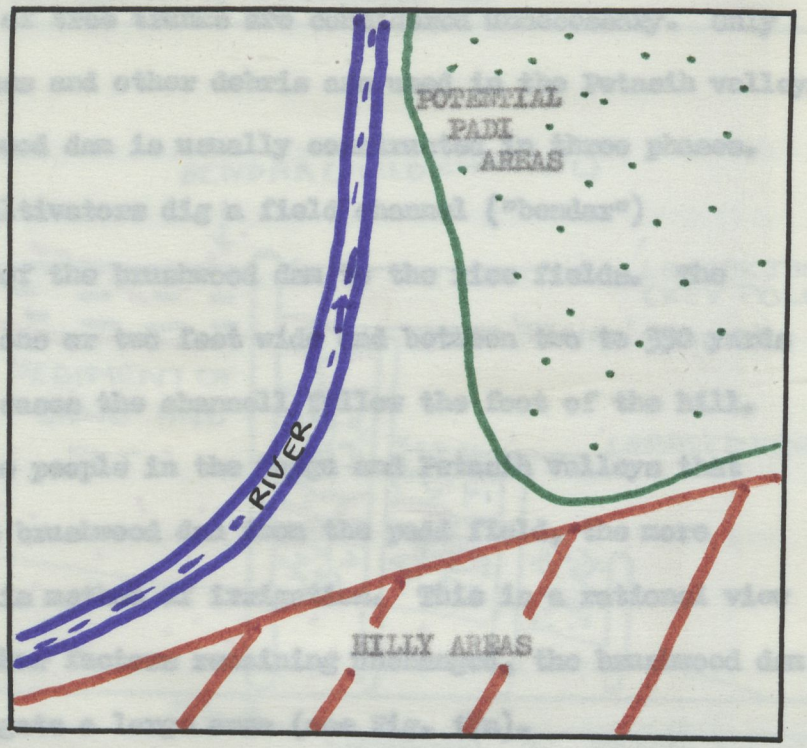


Fig. 3(a)

(b) The preferred site of brushwood dam

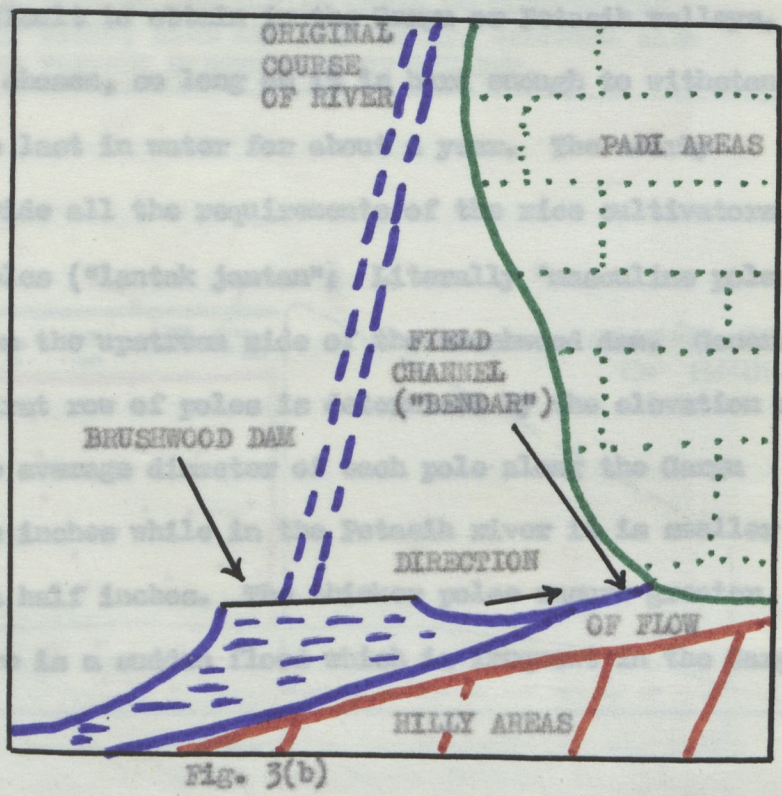


Fig. 3(b)

frequent floods. On the other hand, flooding is rare in the Petasih area and so the use of tree trunks are considered unnecessary. Only poles, branches, grass and other debris are used in the Petasih valley.

The brushwood dam is usually constructed in three phases. Firstly, the rice cultivators dig a field channel ("bendar") connecting the site of the brushwood dam to the rice fields. The 'bendar' is usually one or two feet wide and between two to 350 yards in length. In most cases the channell follow the foot of the hill. It is the view of the people in the Gargu and Petasih valleys that the further away the brushwood dam from the padi field, the more effective will be this method of irrigation. This is a rational view because, assuming other factors remaining unchanged, the brushwood dam will be able to irrigate a large area (see Fig. 17a).

Secondly, poles ("lantak") are planted into the river bed. The best types of wood are the 'resak' and 'merbau' varieties but since these are difficult to obtain in the Gargu or Petasih valleys, any type of wood is chosen, so long as it is hard enough to withstand the hammering and to last in water for about a year. The nearby Forest Reserves provide all the requirements of the rice cultivators.

The key poles ("lantak jantan"; Literally 'masculine poles') form the first row on the upstream side of the brushwood dam. Generally the height of the first row of poles is determined by the elevation of the river bank. The average diameter of each pole along the Gargu river is about three inches while in the Petasih river it is smaller i.e. about one and a half inches. The thicker poles ensure greater protection when there is a sudden flood which is frequent in the Gargu valley.

SKETCH OF CROSS-SECTION OF A BRUSHWOOD DAM

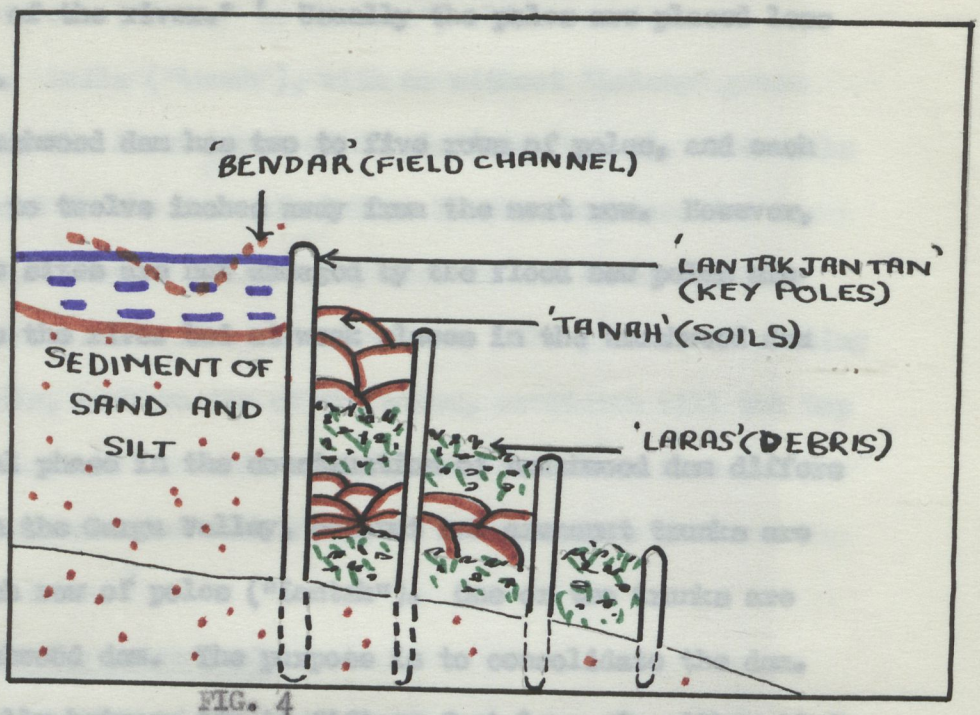


FIG. 4

(Location: B_5 PETASIH VALLEY)

SKETCH OF GENERAL FORM OF THE ABOVE BRUSHWOOD DAM (IN CROSS-SECTION) ABOVE SHOWS THAT IT IS MUCH THICKER AT THE BASE THAN AT THE TOP IN ORDER TO COUNTER THE PRESSURE OF WATER, SAND AND SILT ON ITS UPSTREAM SIDE AND ALSO TO PREVENT UNDERMINING OF THE DAM.

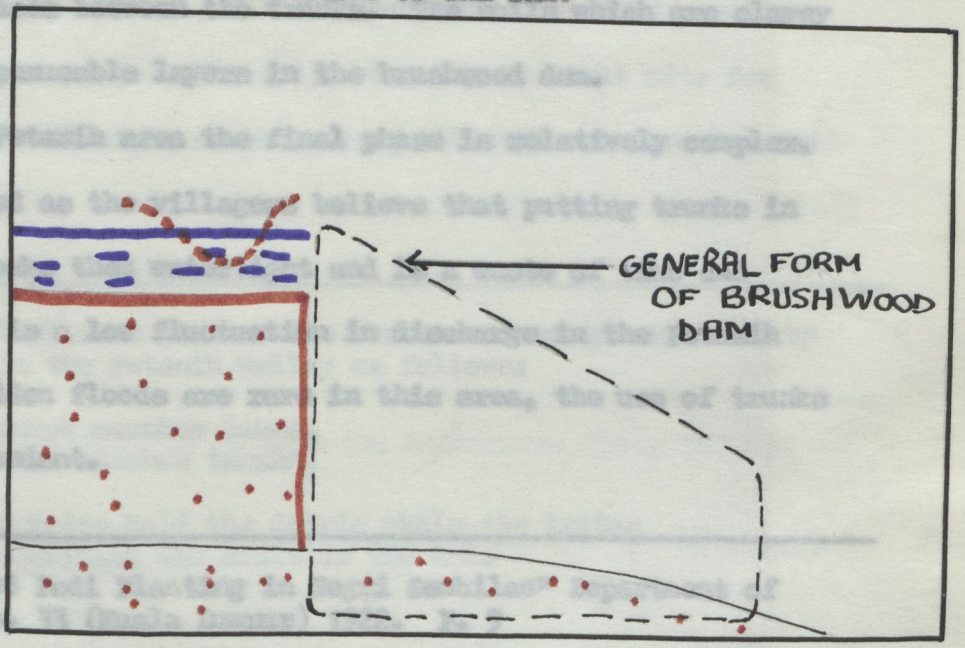


Fig. 5

The distance between the poles and rows 'depends upon the current and depth of the river.' [1] Usually the poles are placed less than a foot apart.

Each brushwood dam has two to five rows of poles, and each row is six inches to twelve inches away from the next row. However, in areas where the sites are not damaged by the flood new poles are merely driven into the river bed at weak places in the brushwood dam (see Plate 11).

The final phase in the construction of brushwood dam differs in both areas. In the Gangu Valley, coconut and arecanut trunks are placed between each row of poles ("Lantak"). One or two trunks are used for each brushwood dam. The purpose is to consolidate the dam. Each trunk, generally between ten to fifteen feet long, is either tied to the poles using "ijok" fibres (i.e. bark of the 'enau' palm which is "resistant to rot whilst wet") [2] or just nailed to the poles. The 'Lalang' grass and soils are then mixed together and laid along the top and in the spaces between the trunks. The soils which are clayey in nature form impermeable layers in the brushwood dam.

In the Petasih area the final phase is relatively complex. Trunks are not used as the villagers believe that putting trunks in the dam does not make them watertight and is a waste of time and effort. As there is a low fluctuation in discharge in the Petasih river and that sudden floods are rare in this area, the use of trunks ("bambam") is redundant.

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1 Grist D.H. "Wet Padi Planting in Negri Sembilan" Department of Agriculture No. 33 (Kuala Lumpur) 1922. P. 9

2 Report of the Drainage and Irrigation Department for the years 1952, 1953, 1954 Government Printer (Kuala Lumpur) P. 99.

Instead the padi cultivators along the Petasih valley use an assortment of debris ("Laras" or "debris") which consists of branches of trees. Soils ("tanah"), with or without 'Lalang' grass are then laid along the first layer of debris (see Fig. 4). The soils are sometine dug out in the form of slabs. In one brushwood dam in the Petasih valley, slabs of soils are placed in the first two rows on the upstream side of the five-row structure. The process of putting the debris and soils, each on top of the other, continues till the top of the poles are reached. In order to make the structure firm the builders of the brushwood dam will stamp on the materials that are placed between the rows.[1]

The Construction of the Waterwheel

The construction of the waterwheel is an equally complicated affair. Site is again an important consideration. The elevation of the bank at the site determines the diameter of the waterwheel which is usually between ten to fifteen feet. The lower the bank elevation the smaller is the waterwheel, and a higher bank elevation requires a much larger structure (see Plate 1). Usually the best site for the waterwheel is a straight river course, although some are located at meanders.

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1 The importance of each part of the brushwood dam is summed up by an informant in the Petasih valley as follows:

"Lantak untok menahan laras,
Laras untok menahan tanah".

Translation: The poles hold the debris while the latter consolidate the soils in the dam.

The actual construction of the waterwheel involves twelve phases or stages:

Firstly, about eight to twelve poles are driven into the river bed. The length of these poles ("tiang") is about equal to the diameter of the waterwheel. The poles when firmly placed, stand about three to five feet above the axle of the assembled waterwheel (see Fig. 8).

In the second phase, notches are cut on the outerside of the two rows of poles. Another set of poles("tayan") is tied, using 'ijok' fibres, to the first set of poles ("tiang"). They are parallel to the level of the river (see Fig. 7).

The third phase involves placing the axle ("giling" or "gilingan") on the "tayan". The axle is of hardwood preferably of the 'batang hunga' variety. It is about eight inches wide at the centre, tapering towards both ends, and about five feet in length. When viewed from the end of the axle, it resembles a polygon (see Fig. 12). The axle, (viewed from the angle) may resemble an eight or twelve-sided polygon. [1]

In the fourth phase, the spokes ('bilah' or 'jari') are then inserted into cavities in the axle. Each end of four spokes are pushed into two cavities on one side of the axle (see Plate 13). Each spoke is about "three fingers wide" (i.e. about two inches). [2]

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1 Source of this information is from two informants along the Ulu Triang river.

2 Related by an informant in Kg. Jalin (along the Ulu Triang River) who built his own waterwheel.

DIAGRAMMATIC REPRESENTATIONS OF CONSTRUCTION OF A WATERWHEEL

PHASE: 1

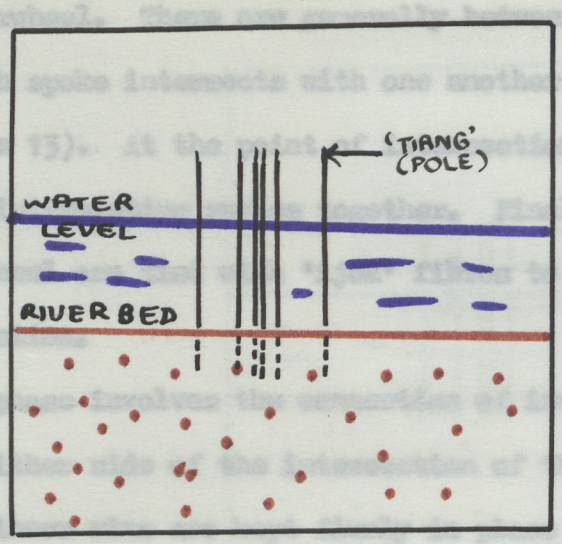

FIG. 6

PHASE: 2

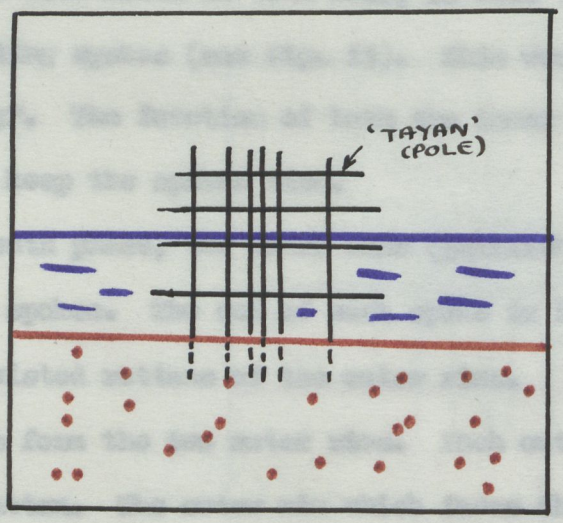

FIG. 7

The spokes are obtained by cutting the 'enau' palm into long strips of wood (or 'ruyong'). The number of spokes varies with the size of the waterwheel. There are generally between 32 to 48 spokes per waterwheel. Each spoke intersects with one another at about half its length (see Plate 13). At the point of intersection "ijok" fibres are used to tie the intersecting spokes together. Finally, all the spokes in the waterwheel are tied with 'ijok' fibres to each other at the point of intersection.

The fifth phase involves the connection of inner rims ('kepok-kepok') to either side of the intersection of the spokes (see Plate 14). The two inner rims are kept firmly in place by tying them together between two intersecting spokes (see Plate 14).

In the sixth phase a piece of wood, about two feet long, three inches wide and with holes at both ends, is used to connect the ends of two intersecting spokes (see Fig. 13). This wood is called "kongkong" or "pasong". The function of both the inner rims and the pieces of wood is to keep the spokes firm.

In the seventh phase, the outer rims (pelilit" or "bingkai") are connected to the spokes. The end of each spoke is inserted between the double-twisted rattans of the outer rims.

The rattans form the two outer rims. Each outer rim consists of three layers of rattan. The outer rim which faces the padi area is usually smaller than the other outer rim (see Plate 6). This is to facilitate the flow of water out of the bamboo container.

In the eighth phase the paddles ("kipas") are connected to the waterwheel. Each paddle consist of about six flattened bamboos and it resembles a piece of weaved material (see Plate 6). The force

PHASE: 3

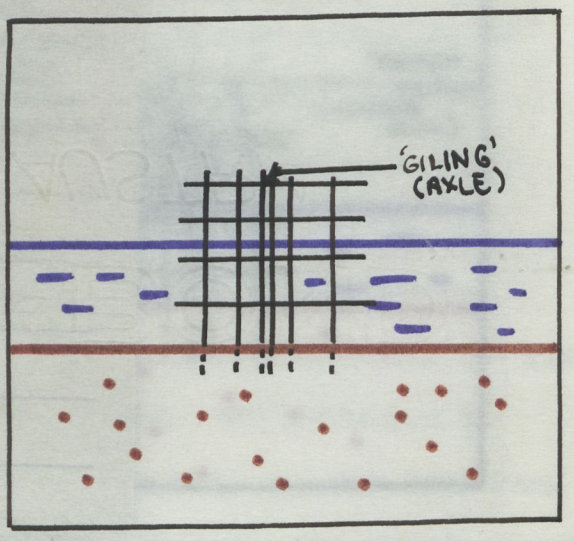

FIG. 8

PHASE: 4

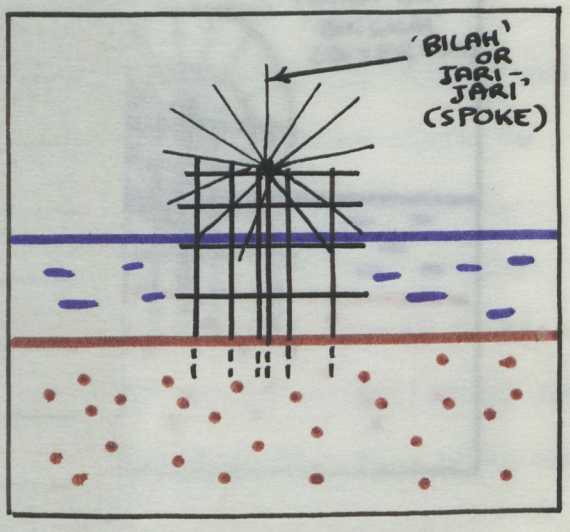

FIG. 9

PHASE: 5

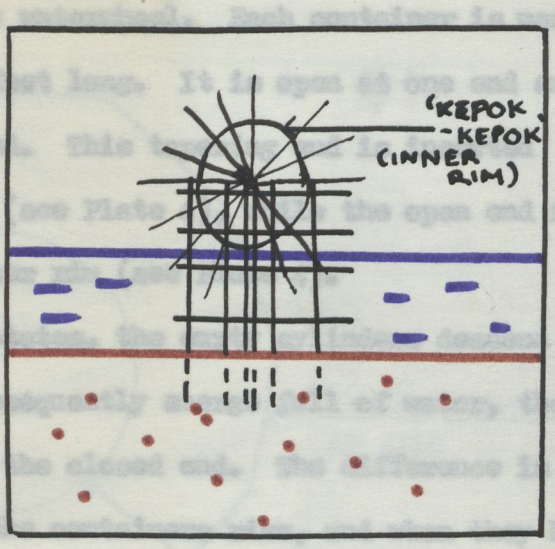

FIG. 10

PHASE: 7

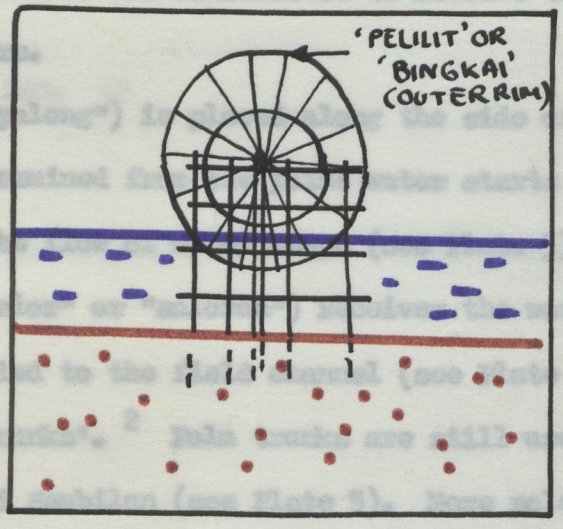

FIG. 11

of water causes the waterwheel to revolve.

The ninth phase involves connecting the water containers ("tabong" or "kanchong") to the waterwheel. Each container is made of bamboo usually about three feet long. It is open at one end and cut to a point at the closed end. This tapering end is inserted between the interwining rattan (see Plate 4), while the open end is lashed obliquely across the outer rim (see Plate 4).

"As the waterwheel rotates, the empty cylinders descend below the river surface and subsequently emerge full of water, the open end being slightly higher than the closed end. The difference in relative levels diminishes as the containers rise, and when they have passed the highest point and begin to move downward, the relative levels reverse and water begin to emerge from the open container ends." [1]

In the tenth phase, flumes are constructed to receive the water from the bamboo containers.

The smaller flume ("palong") is placed along the side of the waterwheel. Its length is determined from the point water starts to flow out of a container till the flow of water stops (see Plate 5).

The larger flume ("salor" or "saloran") receives the water from the smaller flume and is led to the field channel (see Plate 5). The flumes are 'made of palm trunks'. [2] Palm trunks are still used for flumes in remote parts of Negri Sembilan (see Plate 5). More poles are used to support the larger flume.

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1 Report of the Drainage and Irrigation Department for the years 1952, 1953, 1954. Government Printer (Kuala Lumpur) 1955. P. 98.

2 Ibid. P. 98.

DIAGRAM OF CROSS-SECTION OF THE AXLE OF A WATERWHEEL

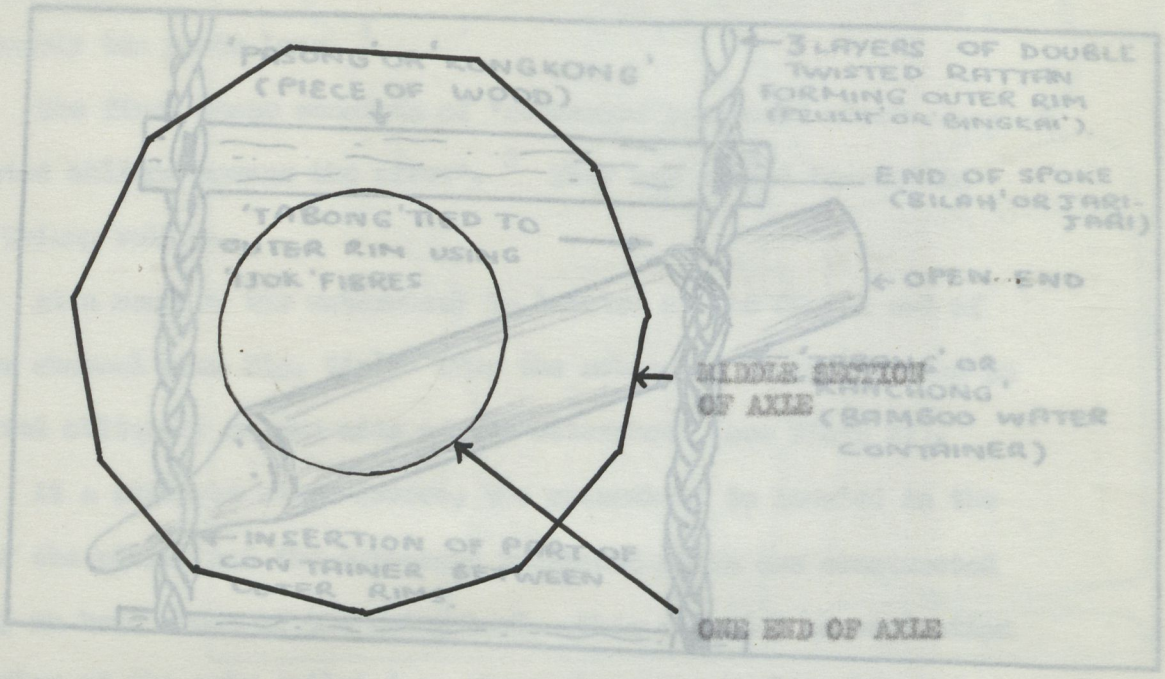

FIG. 12

(LOCATION: KG. JALIN, JELEBU DISTRICT)

SKETCH OF A SECTION OF A WATERWHEEL

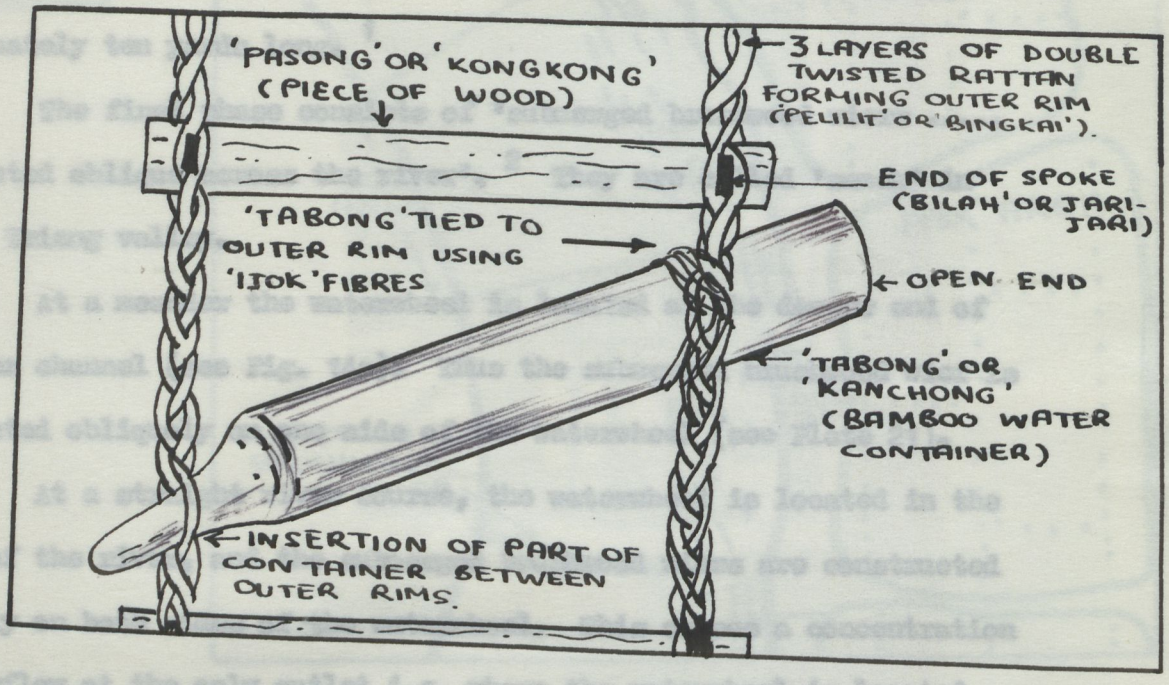

FIG. 13

The eleventh phase involves digging a field channel ("bendar") from the larger flume to the padi field. From existing waterwheel system in Kuala Pilah district, it is observed that the channel are approximately ten yards long. [1]

The final phase consists of 'submerged brushwood wiers ..... constructed oblique across the river'. [2] They are called 'semak' in the Ulu Triang valley.

At a meander the waterwheel is located at the deeper end of the river channel (see Fig. 14a). Thus the submerged brushwood wier is constructed obliquely on one side of the waterwheel (see Plate 21).

At a straight river course, the waterwheel is located in the middle of the river, and the submerged brushwood wiers are constructed obliquely on both sides of the waterwheel. This causes a concentration of waterflow at the only outlet i.e. where the waterwheel is located (see Fig. 14b). This provides the energy to move the heavy waterwheel.

The watersheel in Kuala Pilah district revolves at the rate of twice a minute. However Grist observed that a waterwheel could turn four to five times per minute. [3] Thus the greater the number of revolutions per minute the more efficient is the waterwheel, because it will raise more water for the padi areas.

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1 Kg. Jambul Lapan near Bahau.

2 Report of the Drainage and Irrigation Department for the years 1952, 1953, 1954. Government Printer (Kuala Lumpur) 1955. P. 98

3 Grist D.H. "West Padi Planting in Negri Sembilan" Department of Agriculture Bulletin No. 33 (Kuala Lumpur) 1922. P. 11.

SKETCH MAPS SHOWING LOCATIONS OF SITE OF WATERWHEEL

(a) AT A MEANDER

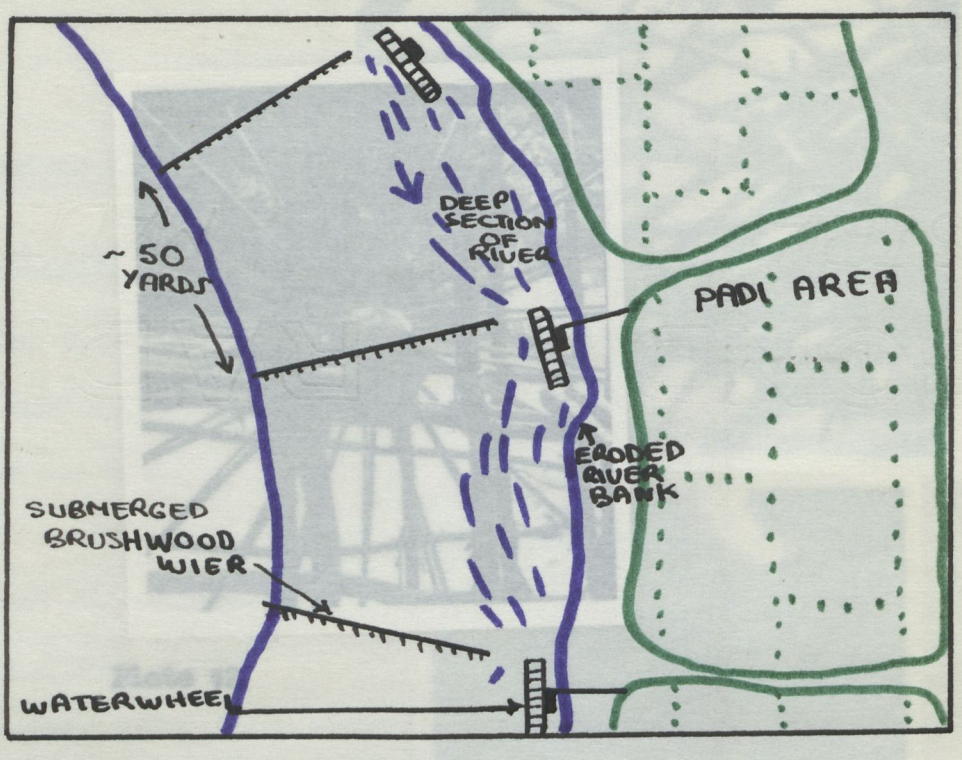

FIG. 14(a) (Location: Kg. Jambul Lapan Kuala Pilah district)

(b) AT A STRAIGHT RIVER COURSE

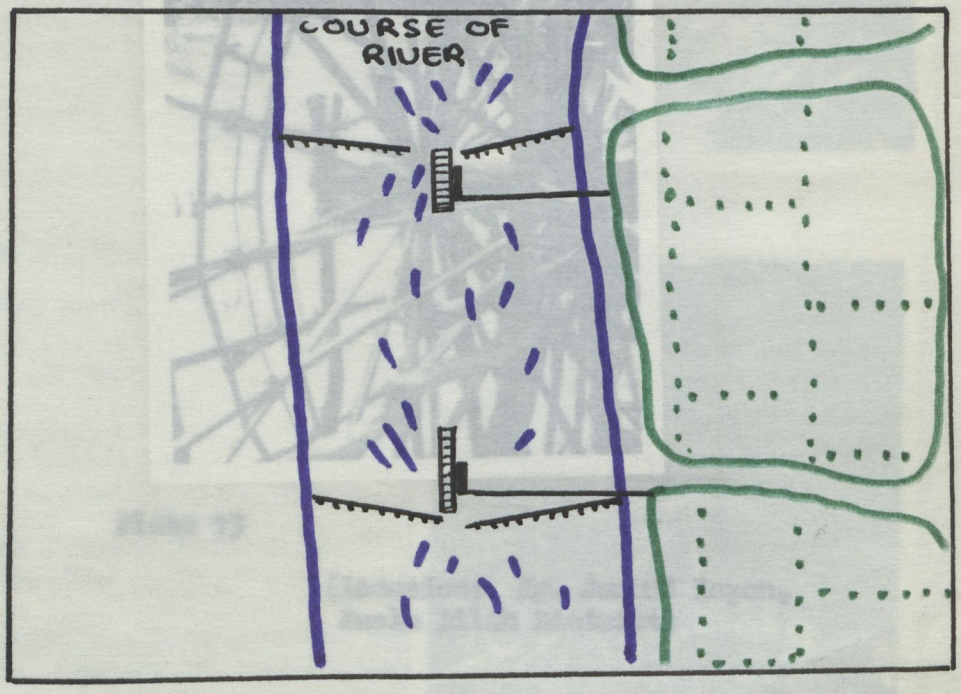

FIG. 14(b) (Location: Jelebu District)

Close-up views of centre of waterwheel

Plate 12

Plate 13

(Location: Kg. Jambul Lapan, Kuala Pilah District)

Photographs of a waterwheel

Plate 14

Plate 15

(location: Kg. Jambul
Lapan, Kuala Pilah
District)

Plate 16

CHAPTER 5

SOCIAL ORGANIZATION OF INDIGENOUS IRRIGATION SYSTEMS

Communal Basis of Indigenous Irrigation Systems

In the three forms of irrigation systems in Jelebu District, cooperation plays a very important role. However the degree of co-operation varies from one system to another. The rationale of co-operation is that "if a man abandons his rubber holding he harms only himself; if he neglect his rice field he harms others". [1]

Utilization of Spring ("anak ayer")

Since padi areas using "anak ayer" are small and isolated, communal assistance is negligible, although mutual assistance exists between two or three individual users of the system. In most cases cooperation is unnecessary because the farmer may be the only user of the "anak ayer". In spite of this he may help in building or repairing a brushwood dam of a neighbour.

The Communal Basis of Brushwood dam system of irrigation

On the other hand, brushwood dam "is an excellent example of communal effort." [2] In fact the very existence of brushwood dam depends on patience and cooperation among its users in particular and among the

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1 Swift M.G. "Malay Peasant Society in Jelebu" Athlone Press Inc. New York 1965. P. 42.

2 Report of the Drainage and Irrigation Department for the years 1952, 1953, 1954. Government Printer (Kuala Lumpur) 1955. P. 98

people in the village in general. The construction of the dam is not a simple effort. There has to be leadership to prevent wastage of labour and to ensure greater coordination especially in determining the time of building the brushwood dam. However "the actual process of decision making involves the opinion of village notables," [1] e.g. the adat chief - the 'Dato Lembaga' [2] provides traditional leadership for his 'Anak Buah' (i.e. the members of the clan).

There is also division of labour in the construction of the brushwood dam. A section of the group involved is required to fetch brushwood and other debris while another section in the group is asked to look for the jungle poles. The tree trunks are obtained near the site as it is too cumbersome to be dragged out of the jungle. The tree trunks are then pulled to the site of the drain. The brushwood dam is finally completed under the direction of an experienced man - the "ketua empangan" (or "ketua'an"). [3]

Before the War traditional leadership played an important role in coordinating irrigation practices along the river because the 'Dato Lembaga' was more powerful than he is now. "Nowadays it is a rare 'Lembaga' who bothers with his clan's rice field". [4]

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1 Swift M.G. 'Malay Peasant Society in Jelebu' Athlone Press Inc. (New York) 1965. P. 155.

2 This term is essentially unique to Negri Sembilan with its matriarchal system ("Adat Perpateh").

3 This term is used by Grist D.H. in "Wet Padi Cultivation in Negri Sembilan". 1922.

4 Swift M.G. 'Malay Peasant Society in Jelebu, Athlone Press Inc. New York 1965. P. 82.

Today the traditional leadership has been taken over by the village headman ('ketua kampong'). Respect for traditional leadership has also been eroded because rice cultivation programmes have become a government concern. It is difficult to organize cooperation for collective work because 'leadership in the village now depends to a very great extent on personality ..... ' and also 'the villagers can buy rice with their income from rubber', [1] assuming a high rubber price.

Although traditional leadership has become insignificant, the importance of communal labour has not diminished in relation to the brushwood dam. Four aspects of cooperation along the Gargu and Petasih valleys can still be observed.

Firstly, the users of a brushwood dam have to come to an agreement with the owner of the land further upstream. This verbal agreement is necessary because the brushwood dam may be located hundreds of yard upstream from the padi field which it irrigates and that the 'bendar' has to be dug across another person's land.

Secondly, a number of people usually related to each other ('waris') may decide to cooperate to build a dam. Since the amount of water can satisfy the demands of a number of farmers it is not necessary for each person to have a separate brushwood dam. The maintenance of the dam is also done collectively.

Thirdly, there may come a time when damages to the system are excessive and beyond their ability to repair it. The assistance of other villagers is then urgently required especially at a time when the padi crop needs water. This occurs more frequently in the Gargu

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1 Swift M.G. 'Malay Peasant Society in Jelebu' Athlone Press Inc. New York 1965. P. 51.

valley than in the Petasih valley. In the former, about thirty persons - both men and women - respond in providing communal labour for the repair or reconstruction of the brushwood dam. In the taller, the assistance of other villagers is rarely required because the brushwood dams in this valley are seldom damaged by flood.

Even communal labour has its limitations. For instance in 1968, there was a case when a brushwood dam was completely swept away on the day of its construction. Consequently large tracts of padi land in the upper reaches of the Gargu river are abandoned because the patience and physical effort of those providing communal labour are exhausted, as damages to the brushwood dam are frequent. This has affected the livelihood of thirteen families in the Gargu valley. It shows that even an intergrated social network of mutual assistance may break down in the terrific struggle against nature.

Finally, a system of sharing out water from both the brushwood dam and the river has to be devised. The users of the brushwood dam not only have to consider themselves but also of users of other brushwood dams. Users of neighbouring brushwood dams will come to a verbal agreement on the amount of water for each brushwood dam. Also in one brushwood dam there is agreement on the amount of water for each user.

In the past each user had to be on guard against a 'water thief' i.e. a user who took more than his allotment of water by breaking the side of the field channel at night and sealing it before dawn. However this anti-social practice does not appear to exist today.

The system of sharing out water from the river may fail when there is no cooperation between two social groups. For instance large tracts of padi land at the lower reaches of the Gargu river are abandoned

because there is little cooperation between the recent Minangkabau immigrants of the upper reaches of the river, and the Malay farmers at its lower reaches.

Cooperation becomes more necessary during a drought. Under this circumstance, users of neighbouring brushwood dam discuss the re-allocation of water. This is made effective by reducing the height of the dam i.e. by removing the upper layer of debris. In a severe drought this communal effort is futile because in reducing the height of the brushwood dam it will cease to command the padi areas (see Fig. 17). Padi areas located at the lower reaches of the Gargu and Petasih valleys suffer adversely during periods of drought and this usually creates disputes.

Since the construction of a dam is a communal effort the question of payment for labour and material does not arise. This is true in both the Gargu and Petasih areas. However in 1922 Grist noted that the cost of construction of a dam and field channel was about seven per cent of total cost or $2.50 out of a total cost of $37.70 to produce an acre of padi. [1] He also observed that payment in money or in kind may be made where one of the contracting parties was unable, either on account of illness or other causes to take his fair share of the work. The "ketua'an", who supervised the construction of the brushwood dam, was unpaid but was allowed by Malay 'adat' to take a small percentage of the crops but in reality this amount was insignificant. [2]

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1 Grist D.H. "Wet Padi Planting in Negeri Sembilan" Department of Agriculture Bulletin No. 33 (Kuala Lumpur) 1922. P. 26

2 Ibid. P. 10.

Organization of Waterwheel System of Irrigation

It has been observed that the brushwood dam system of irrigation requires a great deal of cooperation. Probably there is a reaction on the part of the more individualistic farmer. He may feel that involvement in communal labour costs him the loss of valuable hours - when he has his padi field to tend to. The waterwheel provides for this individualistic trend with the minimum of infringement of other farmer's land and water supply. Waterwheel is used in the larger river because the construction of a brushwood dam involves the co-operation of many clans. This is a cumbersome process and the water-wheel system is the only alternative. Thus in almost all cases along the Ulu Triang River, one waterwheel belongs to one owner although two waterwheels may be owned by a relatively 'rich' farmer e.g. the 'Dato Lembaga'.

In terms of cost the waterwheel is more expensive than the brushwood dam. Before the Second World War the cost of constructing a waterwheel was between $5.00 to $30.00. [1] Today the cost of a water-wheel is about $100.00. [2]

It can also be observed that padi farmers near the towns e.g. Petaling and Kuala Klawang do not build the waterwheel themselves, rather they contract a carpenter and a few helpers to do it. Probably they are comparatively well-off than the rice cultivators along the lower reaches of the Ulu Triang River. It is also possible that since

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1 Grist D.H. 'Wet Padi Planting in Negri Sembilan' Department of Agriculture Bulletin No. 33 (Kuala Lumpur) 1922. P. 11.

Source of this information is also from informants near Petaling and Kuala Klawang.

2 This is the estimate of a padi farmer, who still use a waterwheel to irrigate his padi field, at Kg. Jambul Lapan in Kuala Pilah District.

the construction of a waterwheel is a heavy task, it is easier to delegate the job to a carpenter for an agreed sum as payment.

In villages away from the towns each padi farmer builds his own waterwheel. When the padi farmer builds his own waterwheel he usually get the assistance of his neighbours in assembling the components of the system.

This individualistic system of irrigation is reflected by the numerous waterwheel in the riverine landscape, as each waterwheel is about 50 yards from the other (see Fig. 14).[1]

Beliefs and Rituals ('berpemah') of Indigenous Irrigation Systems

Beliefs in the spirit harden as the rice cultivators are fighting a losing battle against the forces of nature. Rituals and magical interpretations are strong in the use of brushwood dam because it is most susceptible to damage and destruction, than other systems of irrigation. The farmers believe that dams do not break often by chance. If breakages are frequent they suspect 'supernatural malevolence or irritation.[2]

In contrast, beliefs and rituals are almost absent in the use of 'anak ayer' and the waterwheel systems of irrigation, probably because they are relatively individualistic. However when a cultivator finds that the river bank near his waterwheel is badly eroded he believes that by placing pieces of bamboo there, the water spirit ('hantu ayer') is appeased. Probably the rational explanation to this belief is that

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1 This is obtained from observations on four waterwheels in Kuala Pilah district, and also from the estimates of informants along the Ulu Triang river.

2 Swift M.G. "Malay Peasant Society in Jelebu" Athlone Press Inc. (New York) 1965. P. 41.

pieces of bamboo placed at the affected bank reduce the rate of erosion.

The invocation of spiritual aid and placating the wraths of spirits are matters of supreme importance in the construction of a brushwood dam. The rice cultivators believe that unless the spirits are appeased the dam will inevitablely be destroyed by the guardian - spirit of the river ('hantu ayer' or 'penunggu'). A spirit - medium - healer ('pawang') is consulted as he knows the proper incantations and methods of approach. He choses the day "usually a Sunday, as the villagers are proud of their ceremony and like to invite government officials to attend. Every family takes to the dam offerings of glutinous rice coloured with saffron and hard-boiled eggs. The contribution of each family is partly determined by its wealth and status."[1]

The rituals are then performed under the direction of the 'pawang'. Near the site of the brushwood dam he "placates the spirits with spells and offerings of food and incense. Having completed his work he announces the taboos for the following year".[2] For seven days after the completion of the dam, the site and the adjacent padi fields are classified as spiritually restricted areas. It is said that misfortune will befall those who dare break the taboo. The rice cultivators believe that the spirit takes seven days to 'consume' the offerings. One probable reason is that it prevents the village children from swimming in the water of the dam and thus disturbing the structure.

For his work the 'pawang' is paid 42 cents. His work is important to the villagers because indirectly it "underlines the

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1 Swift M.G. "Malay Peasant Society in Jelebu" Athlone Press Inc. (New York) 1965. P. 41.

2 ibid P. 41

importance of rice and rice cultivation ..... removing it from the level of an ordinary activity which anyone may carry out or not as he feels fit." [1] Also "the need to complete the dam before the ceremony can take place is an incentive to get the work finished." [2]

Magical interpretation can also be used as a validation of peasants' attitude towards excessive breakage of the brushwood dam. Swift noted that "in 1954 the dam broke four times in rapid succession and each time (it) was rebuilt. After the fifth breach the reaction of the villagers was that the 'pawang' had failed to placate the spirits properly. They were resigned to losing their crop for the years." [3]

At present the older 'retired' padi cultivators in the Petasih valley laments on the passing of this practice. The present users of the brushwood dams in the Petasih area explain that it is expensive to call a 'pawang' in the construction of a dam. They consider it costly to hold a feast ('kenduri') and also to pay him. As the standard of living of this area deteriorates, the beliefs and rituals are gradually forgotten.

In contrast farmers in the Gargu valley state (often vehemently) that no such beliefs or rituals exist in that valley, either in the past or at present. The absence of beliefs and rituals in this area shows that the recent Minangkabau immigrants are relatively

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1 Swift M.G. "Malay Peasant Society in Jelebu" Athlone Press Inc. (New York) 1965. P. 42.

2 ibid P. 42

3 ibid P. 42

orthodox Muslims. Once a year the users of each brushwood dam hold a small feast where they will offer special prayers ('doa selamat') to God. Belief in some spirits might still underlies this religious ceremony because the entire village sometimes go to the source of the Gargu river to say their prayers.

Thus rituals and beliefs show a deep desire for a successful harvest in the face of such a precarious irrigation system. They give the rice cultivator confidence and strengthen their will to counter the forces of nature.

CHAPTER 6

EFFICIENCY OF INDIGENOUS IRRIGATION SYSTEMS

Indigenous irrigation systems are efficient if they are able to provide a constant supply of water to the padi fields. However the existing systems of irrigation have not been able to regulate water effectively. This irregularity of water supply is a hazard to rice cultivation.

In areas using 'anak ayer' (spring) the farmers usually complain that the water supply is irregular. Sometimes the flow of water stops altogether at a time when it is badly needed. At normal times the water is considered adequate to irrigate one to three acres of padi land.

On the other hand, the brushwood dam is able to irrigate between 5 to 15 acres of rice land in the Petasih and Gargu valleys, but defects in that system of irrigation has reduced its efficiency.

The most serious defect of the brushwood dam is that 'they are constructed solely for the purpose of raising water and no provision for the passing of flood is made.' [1] When heavy flood occurs, water pressure cuts a new channel around the end of the dam causing it to be outflanked (see Plate 17). The river also 'shows a tendency to change its course'. [2] In order 'to retain control over the river the cultivators

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1 Annual Report of the Drainage and Irrigation Department of the Federated Malay States and the Straits Settlement for the year 1936. Government Press (Kuala Lumpur) 1937. P.3

2 ibid P.4

SKETCH OF PROFILE OF BRUSHWOOD DAM ON GARGU RIVER
SHOWING FLOW OF IRRIGATION WATER BY GRAVITY

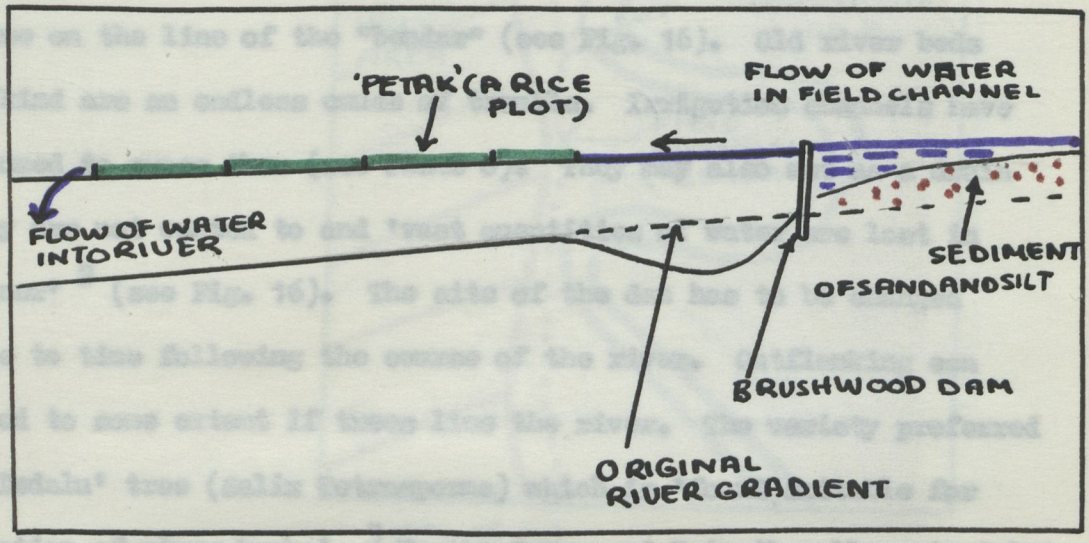

FIG. 15

(Location: B, Gargu Area)

are obliged to extend them'. [1] (i.e. the brushwood dams). But even lengthening the dam has its limitations and when that is reached the structure is abandoned (see Plate 17). In some cases, in both the Gargu and Petasih river valleys, a field channel ("bendar") may be scoured out very severely that the river leaves its bed and forms a new course on the line of the "bendar" (see Fig. 16). Old river beds of this kind are an endless cause of trouble. Irrigation channels have to be flumed to cross them (see Plate 8). They may also act as a drain when they are not wanted to and 'vast quantities of water are lost in this manner' [2] (see Fig. 16). The site of the dam has to be changed from time to time following the course of the river. Outflanking can be reduced to some extent if trees line the river. The variety preferred is the 'Dedalu' tree (Salix Tetrasperma) which is 'found suitable for stabilization of river banks'. [3] In the Gargu and Petasih valleys 'Dedalu' trees are used as natural supports for brushwood dams while reducing out flanking of the dams.

The efficiency of the brushwood dam is also reduced by the "impounding of sand and silt on the upstream side". [4] Since the base level of the river is raised by building a dam, the level of water in it serves as the new base for the river upstream. This reduces the gradient of the river above the brushwood dam and also the velocity of the river on the upstream side. Since the river can no longer carry

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1 ibid P. 3
2 Bush B.O. "Irrigation dams for small rivers" in Malayan Agricultural Journal Vol.21 1933 Carton Press (Ltd) Kuala Lumpur 1934 P. 663.
3 Report of the Drainage and Irrigation Department for the years 1952, 1953, 1954 Government Printer (Kuala lumpur) 1955 P. 20
4 Annual Report of the Drainage and Irrigation Department of the Federated Malay States and the Straits Settlement for the year 1936 (Government Press) Kuala lumpur 1937 P. 3

SKETCH MAPS OF SECTION OF GARGU AND PERASIH RIVERS AFFECTED BY OUTFLANKING

(a) GARGU AREA (B_2)

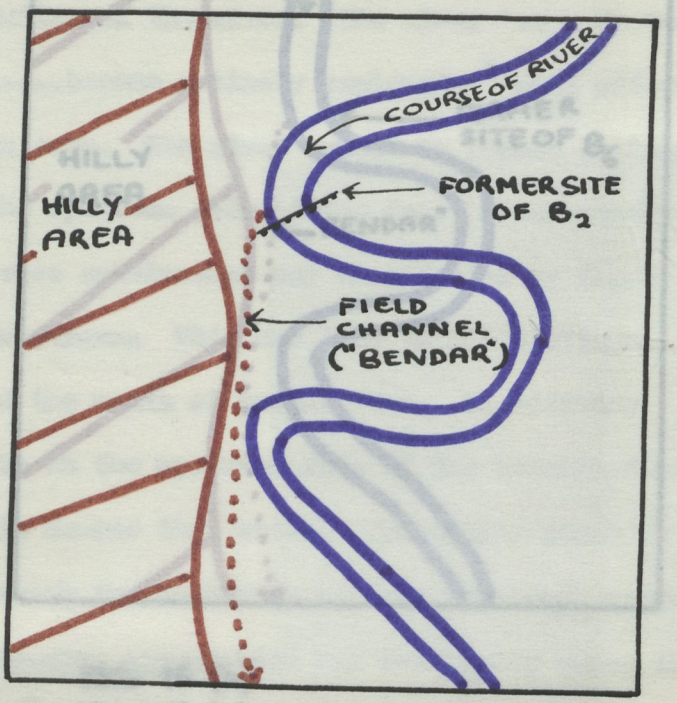

FIG. 16 (a)

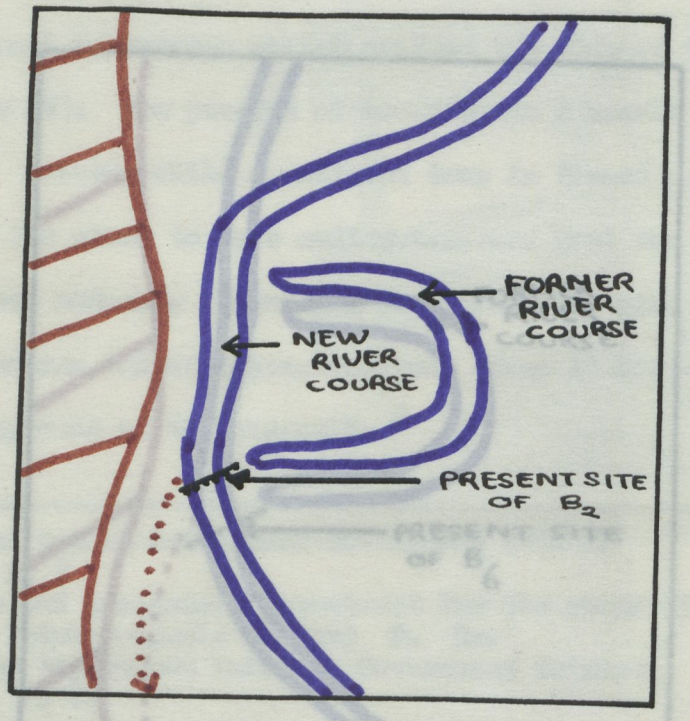

FIG. 16 (a)

(b) PETASIH AREA

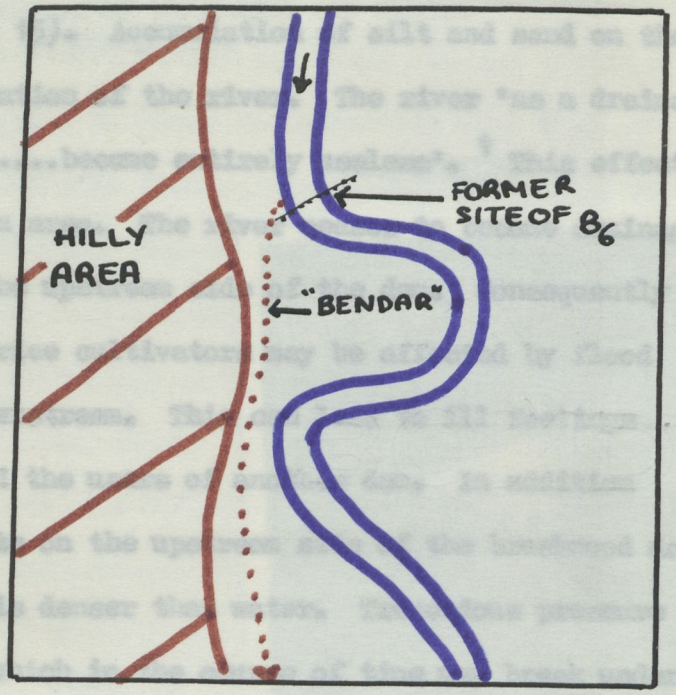

FIG. 16 (b)

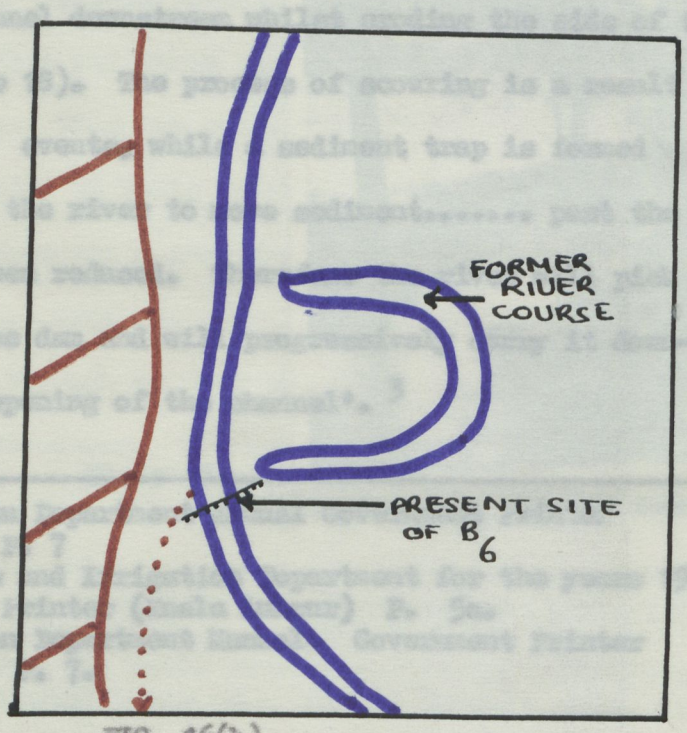

FIG. 16(b)

the material supplied to it, the river begins to deposit sediment in the brushwood dam (see Fig. 15). Accumulation of silt and sand on the upstream side causes aggradation of the river. The river 'as a drainage channel for land upstream.....become entirely useless'. [1] This effect can be observed in the Gargu area. The river ceases to become drainage channel for padi areas on the upstream side of the dam. Consequently padi areas of one group of rice cultivators may be affected by flood aggravated by other dams downstream. This can lead to ill feelings between users of one dam and the users of another dam. In addition when sand and silt accumulate on the upstream side of the brushwood dam it acts as a 'liquid' that is denser than water. Tremendous pressure is thus exerted on the dam which in the course of time may break under the strain. Finally, 'progressive aggradation may eventually cause the river to change its course'. [2]

Another defect of the brushwood dam system of irrigation is the scouring of river channel downstream whilst eroding the side of the bank downstream (see Plate 18). The process of scouring is a result of the following sequence of events, while a sediment trap is formed upstream 'the capacity of the river to move sediment..... past the site of the dam has not been reduced. Therefore the river will pick up bed material from below the dam and will progressively carry it downstream with consequent deepening of the channel'. [3]

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1 Drainage and Irrigation Department Manual Government Printer (Kuala Lumpur) 1959. P. 7

2 Report of the Drainage and Irrigation Department for the years 1952, 1953, 1954 Government Printer (Kuala Lumpur) P. 5a.

3 Drainage and Irrigation Department Manual. Government Printer (Kuala Lumpur) 1959. P. 7.

Features showing defects of brushwood dam system of irrigation

OUTFLANKING

Plate 17

SCOURING

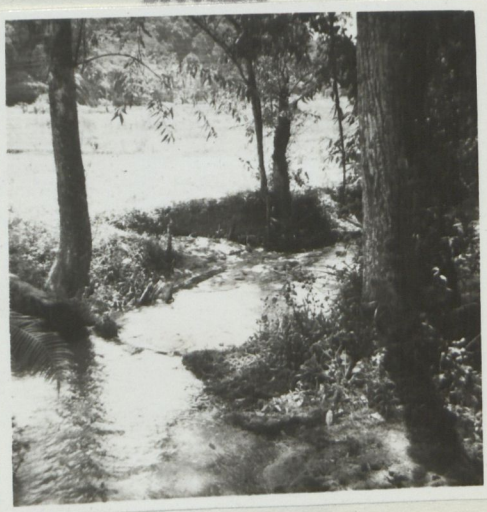

Plate 18

(Location: B_4 (Gargu Area)

Choked field channel may also affect the efficiency of the brushwood dam. During a flood sand enters the field channel ("bendar") and is carried to the padi field as there is no control over flow of water from the "bendar" to the padi field. This occurs frequently in the Gargu valley although the sandy deposit affects only a few chains of padi areas especially those located near the mouth of the field channel. Field channel capacities may also 'progressively decrease due to silting and the growth of water weed.' [1] Choked field channel is a nuisance because 'sometimes the sand travels far enough to ruin the upper reaches of the planted land or.... the oaborious task of lifting the sand out of the irrigation channel must be met when the flood subsides.' [2]

Water losses may also occur as there is lack of control over water in the padi field. When the padi area is slightly undulating e.g. in the Petasih valley, there is concentration of water in certain parts of the padi field. This may cause the water to flow back into the river and goes to waste. This may cause local water shortage since too much water is concentrated in parts of the rice field and little or none in other parts. Consequently a dissatisfied farmer may attempt to build his own brushwood dam. Water is also lost when surplus water finds its way to the river through or over the brushwood dam. This may even undermine the entire structure. However indigenous technology is capable of improving the system. For instance, "below the dam and at

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1 Report of the Drainage and Irrigation Department for the years 1952, 1953, 1954. Government Printer (Kuala Lumpur) 1955 P. 31.

2 Bush B.O. 'Irrigation Dams for Small Rivers' in Malayan Agricultural Journal Vol. 21 1933 Caxton Press Ltd. (Kuala Lumpur) 1934 P. 663.

SKETCHES OF PROFILES SHOWING WHY SOME PADI AREAS GO OUT OF CULTIVATION

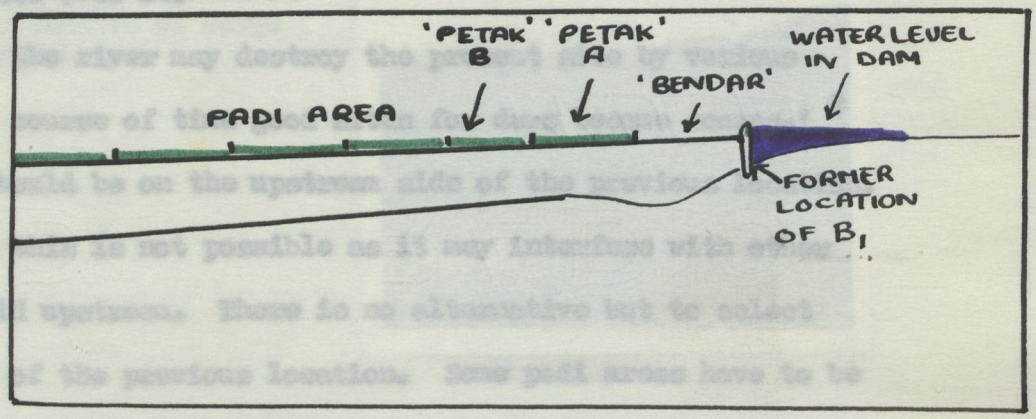

FIG. 17(a)

(Location: B_1 GANGU AREA)

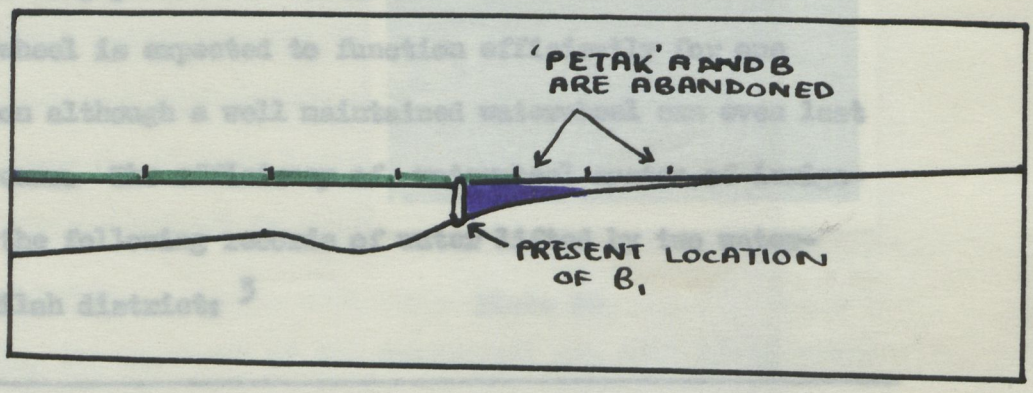

FIG. 17(a)

(Location: B_1 GANGU AREA)

a distance from it of perhaps ten years, a small fragile dam is made of a row of stakes against which are placed split bamboo. This is a very necessary precaution against the danger of undermining of the dam by the fall of water over it. " [1]

Finally the river may destroy the present site by various means and 'in the course of time good sites for dams become scarce.' [2] A suitable site should be on the upstream side of the previous location. But in most cases this is not possible as it may interfere with other farmers' rice field upstream. There is no alternative but to select a site downstream of the previous location. Some padi areas have to be abandoned because the site is not able to 'command' the entire area (see Fig. 17). Even when a new site is found the same cycle of destructive events is repeated. There is progressive abandonment of padi areas especially in the Gargu river valley as suitable sites become scarce (see Plates 19 and 20). In a majority of cases, the sites of the dam do not change over long periods of time.

A waterwheel is expected to function efficiently for one agricultural season although a well maintained waterwheel can even last for two or more years. The efficiency of waterwheel system of irrigation is shown in the following records of water lifted by two waterwheels in Kuala Pilah district: [3]

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1 Grist D.H. "Wet Padi Planting in Negri Sembilan" Department of Agriculture Bulletin No. 33 (Kuala Lumpur) 1922 P. 10.

2 Annual Report of the Drainage and Irrigation Department of the Federated Malay States and the Straits Settlement for the year 1936. Government Press. Kuala Lumpur 1937. P. 4.

3 Grist D.H. "Wet Padi Planting in Negri Sembilan" Department of Agriculture Bulletin No. 33 Kuala Lumpur 1922. P. 11.

Features showing defects of brushwood system of irrigation

Abandoned padi areas at upper reaches of Gargu River Valley.

Plate 19

Abandoned padi areas at lower reachers of Gargu river valley

Plate 20

	Number of 'kanchongs' (bamboo containers)	Amount of water lifted per kanchong	Turns of Water-wheel per minute	Amount of water lifted per turn of wheel (gallon)	Amount of water lifted per Minutes	gallons	hour
1	14	0.60	4	8.40	33.6		2016
2	11	0.34	6	3.74	22.4		1346

This amount of water is adequate for two or three acres of padi land. The efficiency of the waterwheel system may be adversely affected by various factors.

Firstly, poles, logs and other debris may lodge itself at the bottom of the waterwheel eventually halting the movement of the structure. The waterwheel will move only if the debris is removed. If the waterwheel does not move, the components of the structure will become dry and will eventually crack up. The debris may even break the various parts of the waterwheel especially the paddles and the spokes. The bamboo containers themselves are sometime swept away by flood water. Floating logs may also damage the submerged brushwood wier (see Plate 23). Once the wier is breached water pressure that is required to move the waterwheel is reduced drastically and the waterwheel may cease to move.

Secondly, the movement of the waterwheel may also be affected by the level of the river. When water level reaches the axle during a flood, the waterwheel will cease to move. On the other hand when water level drops below the outer rims of the structure, the movement of the waterwheel may also be halted. In order to counter the effect of a low river level, the height of the submerged brushwood wier is raised.

However there is a limit to this effort. Low water level has been a long-standing problem for padi cultivators in this area as shown in the following extract.

"Padi planting was very late for this district owing to a severe drought in the middle of the year. The streams were lower than they had been known for a large number of years ..... there were not enough water to turn kinchirs to any purpose." [1]

Thirdly, the banks are liable to be badly eroded during a flood (see Plate 22). The rice cultivator may attempt to fill the area affected with soil, otherwise a few acres of padi land may be affected by erosion. However refilling the affected areas has serious limitations because communal labour is negligible in the waterwheel system of irrigation; there is a poor response for assistance.

Finally, at the end of each year most of the parts of the waterwheel has to be replaced owing to decay. The spokes, bamboo containers, rims and paddles are replaced annually. The exceptions are the poles and the axle. The axle is discarded only after notches are formed in both ends, usually after three or four years.

When the padi crop ripens the flow of water from the various indigenous irrigation systems is halted.

The barriers are removed from channels in areas using "anak ayer". This causes the water to flow through its original channel.

In the brushwood dam system the debris at the top layers of the structure is removed till the level of water in the dam is the

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1 'Report on the Jelebu District for the year 1904' in the Supplement to the Negri Sembilan Government Gazette. Federated Malay States Printing Office (Kuala Lumpur) 1905. P. 6.

Features showing defects of waterwheel system of irrigation

Plate: 21
(Breached wier)

Plate: 22
(Bank erosion)

Plate: 23
(Wier breached by a log)

(Location: Kg. Jambul Lapan, Kuala Pilah District)

same as the level of the bed of the field channel. The flow of water into the rice field is thus halted. This is the method used in the Petasih valley. In the Gargu valley the entire dam excluding the tree trunks ("bemban") may be removed.

Halting the flow of water into the rice field is equally simple in the waterwheel system of irrigation. It merely involves the removal of the bamboo containers, the flumes or the submerged brushwood weir.

CHAPTER 7

CONCLUSIONS

Several conclusions can be made about indigenous irrigation systems.

Firstly, the social organization of indigenous irrigation systems tends to disintegrate and disappear, even before the Government's involvement in rice irrigation e.g. the waterwheel systems is very individualistic. When Government's dams are built "the peasants tend to adopt a negative attitude to the whole affair."[1] This shows that the social organization of indigenous irrigation systems will fade away in the course of time.

Secondly, indigenous irrigation systems will gradually disappear from the Jelebu rice landscape. Permanent government dams for irrigation had been replacing the outmoded systems since 1918. About that period the British Resident "instructed officers of the Public Works Department in Negri Sembilan to attend to matter of water control and help the Malays in making sound dams in proper places."[2] Today the outmoded irrigation systems exist in few small and isolated padi areas

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1 Swift M.G. 'The accumulation of capital in the peasant economy' in Readings in Malayan Economics. Editor Silcock T.H. (Eastern University Press) Singapore 1961 P. 35.

2 Grist D.H. "Wet Padi Planting in Negri Sembilan". Department of Agriculture Bulletin No. 33. Kuala Lumpur. 1922. Preface by Haynes A.S.

viz. along the Petasih, Gargu, Spri and Palong (near Pertang) rivers, in Jelebu district. The Government is now planning to construct a dam with the purpose of supplying irrigation water to areas in Gargu valley.

The use of the waterwheel became redundant about two decades ago when permanent headworks were built near Kuala Klawang. This was followed by the government's ban on the use of waterwheel along the river. However the owners of waterwheel were given about $30.00 each as compensation.

It is interesting to note that the use of "anak ayer" continues although all the other rice fields use water from the permanent headwork. This system will probably linger for sometime as the headwork does not serve this isolated section of the padi areas.

Finally, it is not possible to introduce double cropping of padi in this area because the indigenous irrigation systems do not guarantee a constant supply of water even for one padi crop. In order for double cropping to be carried out and to give greater productivity per acre the indigenous irrigation systems must be replaced with more permanent systems.

Appendix I

Glossary of Malay terms connected with indigenous irrigation systems

(A)	'Anak Ayer'	:	Spring
(B)	'Ampangan Kayu'	:	brushwood dam
	(1) 'bendar'	:	field channel
	(2) 'lantak'	:	a pole
	(3) 'lantak jantan'	:	a key pole
	(4) 'bemban'	:	tree trunk
	(5) 'laras'	:	debris
	(6) 'tanah'	:	soils
	(7) 'petak'	:	a rice plot
	(8) 'pawang'	:	Spirit-medium-healer
	(9) 'beremah'	:	rituals involved in the appeasement of a spirit
	(10) 'ketua ampangan' or "ketua'an"	:	an experienced man who supervises the construction of a brushwood dam.
	(11) 'pantang'	:	taboo
(C)	'kinchir'	:	a waterwheel
	(1) 'tiang'	:	a pole which is driven into the river bed
	(2) 'tayan'	:	a pole which is tied to the 'tiang'
	(3) 'bilah' or 'jari-jari'	:	a spoke
	(4) 'ijok'	:	a cord made from the bark of 'enau' palm
	(5) 'pasong' or 'kongkong'	:	a piece of wood which hold the spokes together

(6) 'kepok-kepok' : inner rim

(7) 'kipas' : a paddle

(8) 'bingkai' or 'pelilit' : outer rim

(9) 'tabong' or 'kanchong' : a bamboo water container

(10) 'giling' or 'gilingan' : axle

(11) 'palong' : small flume

(12) 'salor' or 'saloran' : large flume

(13) 'ruyong' : strip of wood obtained from the 'enau' palm

(b) Indigenous units of measurement.

(1) 'hasta' : the length from the elbow to the tip of the finger (about one foot).

(2) 'depa' : two arms length

(3) 'jari' : the length of width of a finger.

When the distance is greater than a number of meaningful 'depas' the length is compared to the length of a coconut or an areca-nut tree.

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(5) Fisher C.A. "South-east Asia - A Social, Economic and Political Geography". Methuen and Co., Ltd., London. 1964 P 283.

(6) Grist D.H. "Wet Padi Planting in Negri Sembilan". Department of Agriculture Bulletin No. 33. Kuala Lumpur. 1922 P 7, P_p 9-11, P 26.

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(13) 'Report of the Jelebu District for the year 1907' in the Supplement to the Negri Sembilan Gazette. Federated Malay States Printing Office, Kuala Lumpur. 1908 P. 4

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(16) Swift M.G. "The accumulation of capital in the peasant economy" in Readings in Malayan Economics Editor Silcock T.H. Eastern University Press Singapore 1961 P 35.