ASSESSMENT OF HYDRAULIC SYSTEMS FOR COASTAL WETLAND DEVELOPMENT IN ASAJAYA, KOTA SAMARAHAN

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To my beloved parents and friends

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ABTRACT

Asajaya Drainage Scheme Project is a long term project. The total area of the project is 18,143 ha. It required 20 years to accomplish the whole 4 Blocks (Block 1, 2, 3 and 4). Most of the areas in Asajaya are covered by the coasted wetland areas. In nature, these lands are not suitable for agriculture and it is very hard to develop them. A detail and proper designs of the hydraulic systems for the project development need to be done. The assessment will be done on the hydraulic systems such as drainages, tidal control gates, culverts and how these systems play an important role for the Asajaya Drainage Scheme Project. The objectives of this study is to assess the hydraulic systems in developing the coastal wetland areas into agricultural and crops plantation areas in Asajaya. Some of the problems have arisen during the stages of development and implementation period for Block 1, 2 and 3 before constructing the Block 4. Literature Review had been used to help in understanding the project and the stages development. After identified the problems, the solutions for the problems was carried out to help in improving the existing hydraulic systems. The local data of daily rainfall and surveys had been collected. Through the data and calculation, a proper drainage module had been introduced and the numbers and location for the structures had been identified for the project areas to solve the conflicting between the drainage demand and navigation demand. Besides, a 500 ha area of land had developed to become the pilot area before develop the rest of the area in Block 4. Suitable structures had been designed for tidal outlet structures.

ABSTRAK

Project saliran air Asajaya merupakan projek yang memakan masa yang lama untuk menyiapkannya. Project ini merangkumi kawasan seluas 18, 143 hektar. Projek ini menggunakan masa selama 20 tahun untuk menyiapkan keseluruh 4 Blok iaitu Blok 1, 2 3 dan 4. Kebanyakkan kawasan di Asajaya diliputi oleh tanah paya pantai. Secara semulajadi, kawasan ini tidak sesuai dan sukar untuk melakukan kegiatan pertanian. Perancangan yang teliti terhadap tanah ini melalui sistem hidraulik perlu dilaksanakan. Pernilaian terhadap penggunaan sistem hydraulic seperti parit, pintu kawalan air pasang - surut dan pembentung serta bagaimana sistem hidraulic ini memainkan peranan yang penting dalam Projek Asajaya. Objektif utama pengajian ini ialah mengetahui lebih lanjut tentang pernilaiannya menggunakan sistem hidraulic dalam memajukan kawasan tanah paya pantai kepada kawasan pertanian dan pernanaman untuk meningkatkan pendapatan penduduk tempatan. Selain daripada itu, sistem hidraulik dapat mengelakkan air laut dari mengalir ke kawasan pernanaman semasa air pasang dan mengelakkan kawasan tersebut dibanjiri oleh air hujan semasa musim hujan. Sesetengah masalah telah berlaku dalam peringkat pembinaan dan waktu perlaksanaan project untuk Blok 1, 2 dan 3 sebelum pembinaan Blok 4. Melalui *Literature Review,* ia dapat membantu dalam kefahaman terhadap projek dan peringkat pembinaan projek. Masalah –masalah yang timbul dapat dikaji dan dikanlpasti melalui data-data dan informasi dahulu yang telah dikumpul. Sebahagian masalah yang dapat dikenalpasti ialah ketidaksesuaian saiz model parit, konflik antara penggunaan sistem sebagai parit atau sebagai pengangkutan air, reka bentuk saluran keluar air pasang dan surut serta masalah terhadap parit di tanah gambut. Selepas masalah – masalah dikenalpasti, cara penyelesaianya telah dibawa keluar dalam membaiki sistem hidraulik yang telah dibina. Data untuk air hujan tahunan telah dikumpul. Melalui data-data dan pengiraan, model parit yang sesuai telah diperkenalkan dan bilangan serta lokasi untuk struktur telah dikenalpasti untuk mengelakkan konflik antara penggunaan parit sebagai hidraulik sistem atau pengangkutan air untuk bot. Selain daripada itu, tanah seluas 500 hektar telah diggunakan sebagai kawasan panduan sebelum memajukan kawasan yang seterusnya dalam Blok 4. Struktur yang sesuai telah direka untuk salluran keluar air pasang dan surut.

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Q - Average discharge

A - Drainage area

P - N- day design rainfall

C - Runoff coefficient

K - A real reduction factor

$\mathbf{Q_d}$ - Design discharge

Dm - Drainage modulus

A - Drainage area

n - Number of consecutive days

D(n) - Surface drainage run off over n days

$\mathbf{R(n)_T}$ - Rainfall in n consecutive days with a return period of T years

IR - Irrigation supply

ET – Evapo - transpiration

p - Percolation

Δs - Additional storage

X - No. of culverts

Y - No. of locks

$\mathbf{Q_C}$ - The average discharge from one culverts over an 18 hour opening period

$\mathbf{Q_L}$ - The average discharge for a lock structure over an 18 hour opening period

F - Reduction factor for drowned flow which varies with the submergence ratio.

C - Coefficient of discharge taken as 1.65.

H - Head across structure.

B - Width of structure.

CHAPTER 1

INTRODUCTION

1.1 Background

Agricultural development is the major industry for the Sarawak region. More than 0.4 millions hectares of the Sarawak wetland or lowland has been alienated for agricultural development and reforestation. Agricultural activities become the most important activities or development sector in Sarawak. Through the agricultural development, it will help to raise the productivity, living standard and incomes of the farmers through provision of improved drainage facilities, access roads and intensified supporting services. Most of the coastal areas in Sarawak are covered by the wetlands. The land utilizations record shows that the total areas of the Sarawak region that developed for the agricultural and plantations purpose are intercrops (36%, 12,362.2 Ha), paddy (28%, 9416.7 Ha), oil palm (15%, 5063 Ha), coconut (12%, 4160.8 Ha), cocoa (1%, 282.5 Ha) and others (8%, 2667 Ha). Drainage plays an important role in wetland reclamation. On the other hand, reforestations will help to protect the erosion of the land from the heavy rain.

Kota Samarahan is the Division that is covered by the large areas of lowland in Sarawak where most of it are tidal areas. The total of the areas in Kota Samarahan that covered by wetlands is about 21, 643 Ha but the 81% of the Kota Samarahan Divisions

have been developed for agricultural and plantations purpose. The major agricultural development areas in Kota Samarahan Division are Samarahan Hilir Scheme (785 Ha), Kampong Mang Scheme (422.0 Ha), Asajaya Scheme (14,179.0 Ha), Sebarang Bajong Scheme (1386.0 Ha), Paya Payang Scheme (34.7 Ha), Paya Mending Scheme (40.0 Ha), Sadong Krang Scheme (225.4 Ha); Lubok Buntin Scheme (202.2 Ha) and Sadong Tengah Scheme (546.0 Ha). The hydraulic systems such as drainages and irrigations systems have been built to prevent the intrusion of salt water, flood control and water level control for better water management at farm level.

DID (Department of Irrigation and Drainage of Sarawak) is the main government sector in the development of the wetland areas especially in the designing of hydraulic systems such as drainages and irrigations for agricultures and plantations purpose. Besides, the IADP (Integrated Agricultural Development Project) of Samarahan also helping in development of the wetland areas by building the roads to plantation areas, drainages, irrigation and other hydraulic infrastructure. Agricultural Department also helping in developing the wetland areas in Kota Samarahan. Through the development, these projects will help to raise the productivity, living standard and incomes of the farmers and improve access roads and intensify supporting services.

The total area for Asajaya Drainage Scheme Project is 18,143 hectares. (see Figure 1.1). The Asajaya Drainage Scheme Project also known as Nonok Sub-Project area. It is located between South China Sea in the north, Batang Samarahan in the west and Batang Sadong in the east in Samarahan Division, Sarawak. These Block1 (3,441 hectares), 2(2,479 hectares), 3(2,012 hectares) and 4 (10,211 hectares) are located in Asajaya District. The land under agricultural activities consists 89% or 15,163 hectares

of cultivated area. This includes the plantation of coconuts, cocoa, paddy, oil palm, fruits and vegetables. The activities of maintenance are used to ensure good drainage system for agricultural development including cleaning internal and perimeter drains, rivers and it tributaries. It also helps in operation and maintenance of all the drainage structures including tidal control gates, culverts and bridges.

There are 7 main rivers flow in that area such as Batang Samarahan, Sungai Moyan, Sungai Asajaya, Sungai Sampun, Sungai Jemukan and Sungai Sadong. Besides, the structures such as, tidal controls gates – 22 nos., tidal control flap gates – 6 nos., river diversion and canal have been build. The existing drainage consists of artificial drain dug by the farmers is used to divert run-off from the peat doom to Samarahan river. There are small farm drains which dug by the farmers between 4 rows of coconut tree which used as drainage for their coconut farm.

The project was also involved the widening, deepening and riverbank protection, coastal erosion control, perimeter bund and drains; internal bund and drains, farm road and bridges and site offices and quarters also have been built. The main objective and purposes of having the hydraulic systems in those areas are important. The systems are used to prevent the intrusion of salt water during the king tide; prevent the flood during the rainy season, to develop the land within the project area for agricultural purposes such as increase the agricultural yield. The development of the drainage facilities will provide a better internal drainage of the whole area and reclaim more land with coastal bund and erosion protection work.

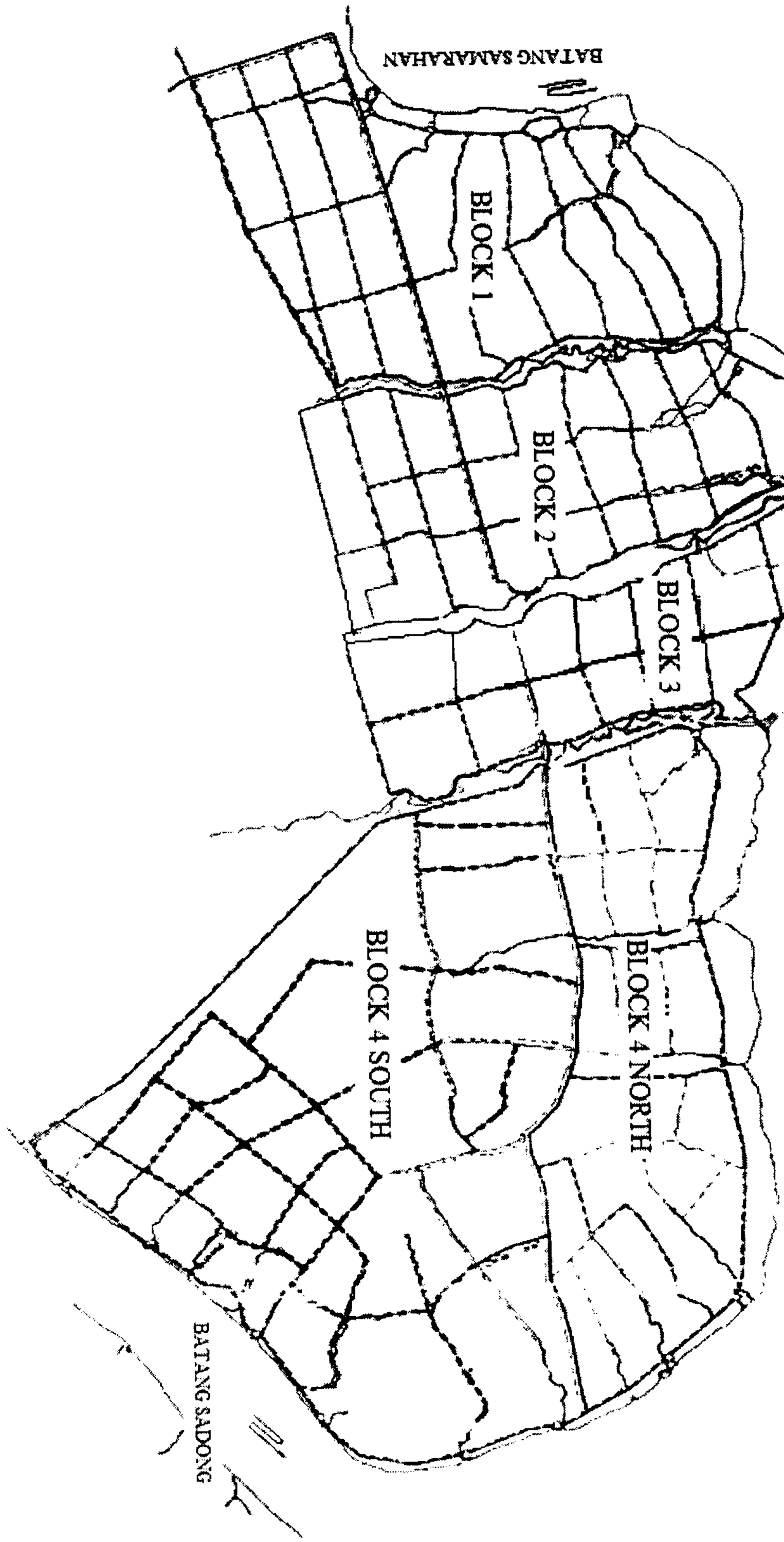

Figure 1.1 Asajaya Drainage Scheme Project (**Source**: *Department of Irrigation and Drainage of Sarawak*)

1.2 Asajaya drainage layouts

The design concept of the project for Asajaya Drainage Scheme is to improve the agricultural area by preventing the tidal inundation of the area which developed by the construction of suitable coastal bund. Then provided an adequate drainage from the project area by construction the internal drainage system and suitable outfall structures through the coastal area. Besides, it is used to provide adequate access within the scheme to meet the requirements of maintenance, agricultural and social needs.

Two major factors have been considered during the construction. These were technical and social factor. Technical factor has to consider the ground topography, rainfall, drainage intensities and soil type. The social factors considered from farm boundaries, minimization of land acquisition or compensation cost. The existing rivers and drains have been incorporated into the main drainage system to reduce the construction cost. During design the drainage scheme of the Asajaya project, the drainage system has been designed to achieve an optimum level of drainage. Some of the factor need to be considered which are applicable to the local climate, soil type, pre – determined cropping pattern of the project area and presence of acid sulphate and peat soils.

Drainage control structures which located along internal drains used to regulate water level in drain to reach optimum level of drainage. Tidal gates and hydraulic control structures designed to later for the chosen drainage criterion. Drainage control structures had been designed against 10 year return period and 48 hours duration storm. The gravity drainage was adopted wherever possible and lock gate was designed to

allow navigation of boats. Tidal gates, which build by reinforced concrete structures with aluminum gates operated by mechanical devices.

The river improvements work shall be designed to provide a reasonable level of protection against the flooding by bank over spill. The extent and limit of river based on consideration of engineering cost, benefits, availability of reserve, navigation requirement, saline intrusion and social acceptability.

Based on information from DID Samarahan, the hydraulic system (see Figure 1.2) at Asajaya Drainage Scheme using anjir system (see Figure 2.3) as hydraulic systems to drain out the rainwater from the field during raining season. The drainage of the Asajaya Drainage Scheme depends on few major rivers flowing in a northerly into South China Sea such as Sungai Moyan, Sungai Nonok, Sungai Sebandi, Sungai Sampun and Sungai Semera.

The diverts runoffs from the peat doom flow into Samarahan River. Small farm drain dug by farmers between 4 rows of coconut tree, which play an important role on the drainage of their coconut farm. Primary drainage functions as collecting and draining out the rainwater into canal. From the canal the water will flow until reaching the lock gates. Lock gates will function as to control the water level of the canal and also the field. From the lock gates, rainwater will flow into the Batang Samarahan and also Batang Sadong. Besides, the rainwater will also flow into the South China Sea.

The tidal gates and perimeter bund are used to prevent the rainwater from flowing into the field that will destroy the crops inside the field. Tidal gates will control the water level inside the field as well. When the water level in the field increases, tidal

gates will be open to allow the access rainwater to flow out from the filed. During the king tides, he time operation of the tidal outlets are restricted by the high tide. It is estimated that the gates at the tidal outlet structures will be closed for 6 out of 24 hours. Then the water will stored within the drains.

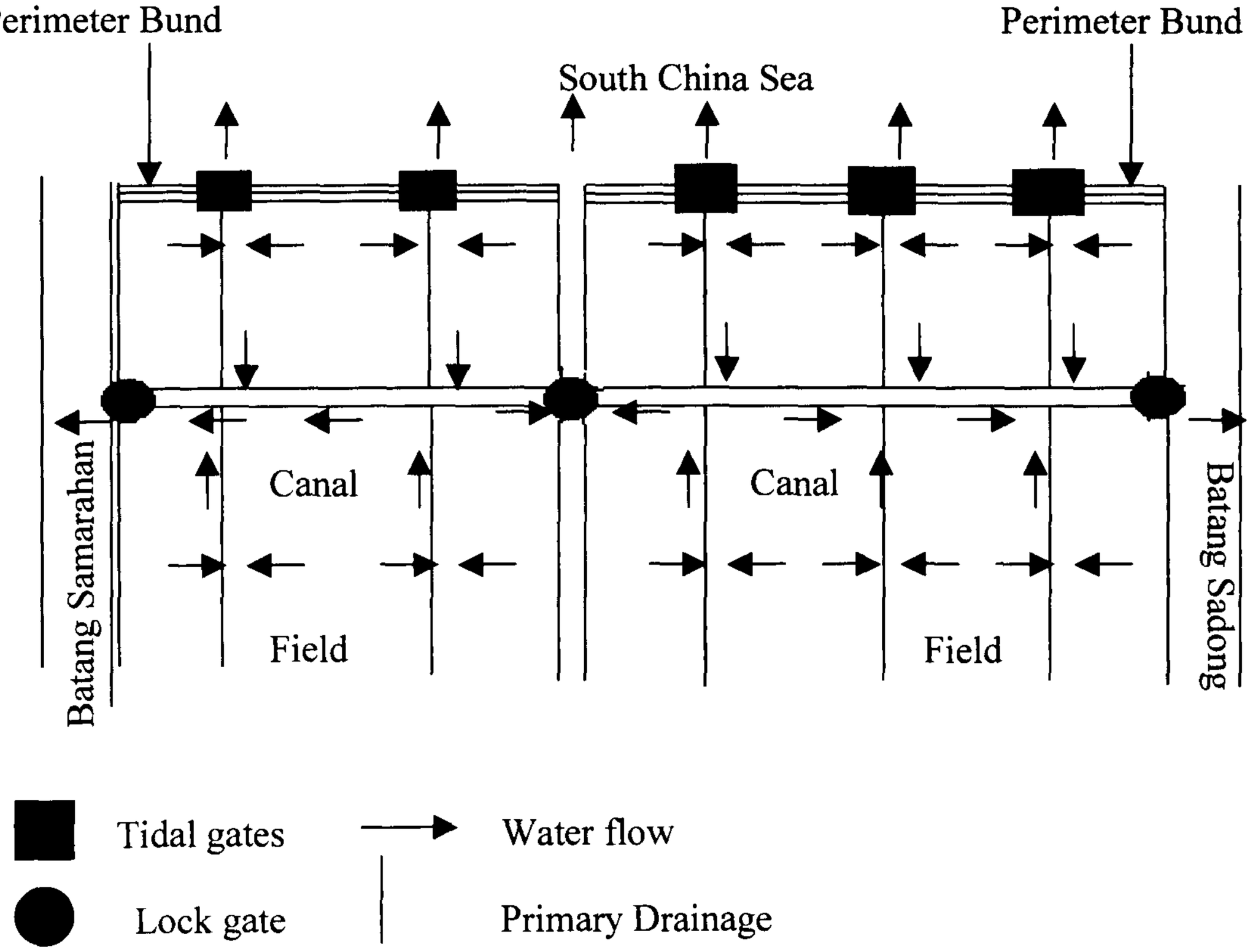

Figure 1.2: Water flow for the Asajaya Drainage Scheme

1.3 The objective of the study

1. To make an assessment about the stages of the Asajaya Development Project and to describe the current stages of development.

2. To find out the problems arising during the operation of the hydraulic system.

3. To suggest the options for problem solution, base on the current practices in either similar projects in Malaysia or other countries.

4. To identify the lessons to be learnt from the Asajaya Project.

CHAPTER 2

LITERATURE REVIEW

When a reliable and suitable supply of water becomes available for agriculture it can result in vast improvements in agricultural production and assure economic returns to the grower. Soil reclamation and management, erosion control, and drainage practices must be developed for the local conditions and applied rigorously. But water management, delivering water to the farms and on the farm itself, is the key to successful irrigation projects.

Water is a renewable resource that naturally follows the hydrologic cycle. The hydrologic cycle is basically a continuous process with no beginning or end that can be represented as a system. A system is a set of interconnected parts or components that form a whole hydrologic cycle. The component that form hydrologic-cycle system are precipitation, evaporation, runoff and others phases. The global hydrologic cycle represented as system can be divided into three basic subsystems, the atmospheric water system containing the precipitation, evaporation, interception and transpiration processes, the surface water system containing the overland flow, surface runoff, subsurface and ground water outflow, and runoff to streams and the oceans processes and subsurface water system containing the processes of infiltration, groundwater recharge, subsurface flow and ground water flow.

2.1 River basins as boundary condition

Hydro-system can be divided into the 2 main systems, the nature and the man-made system, which hydrology system is the nature that represent by river basin and hydraulic systems can be refer to man-made system such as drainages and irrigations canals. Professor V.T.Chow collectively describes, "The technical areas of hydrology, hydraulics and water resources or in others name, hydro-systems. Hydro-systems has also been a term used for reference to types of water projects including surface water storage systems, ground water systems, distribution systems, flood control systems and drainage systems. The premise is that hydro-systems engineering and management can be subdivided into water supply engineering and management, water excess engineering and management."

"The hydraulic infrastructure consists of a network of canals and structures. Canals are named and numbered. It is proposed to define a tertiary canal as a canal to which the individual farmer has direct access. The tertiary canal serves more than one farmer. As a consequence a tertiary canal may be connected with the river via secondary and primary canals, but may also connect directly with the river, J.C.Heun (1993)".

J.C.Heun describes, "Water – levels and salt intrusion are the most important reclamation determining aspects of the river. The upland discharge and stability of the river bed are the next ones, but are less easy to generalize with respect to reclamation influencing factors. Whether the wet season water levels differ much from the dry season water – levels depends upon the upland discharge. Also sudden rises (flash floods) may occur, but they are less likely to occur in the tidal reach or if they occur, they are less extreme than in the upland reach. The mean sea level may be several

decimeters higher in the wet season than in the dry season. This is caused by the monsoon winds." The figures below, (Figure 2.1 and Figure 2.2) show the effect of upland discharge and characteristics of river reaches.

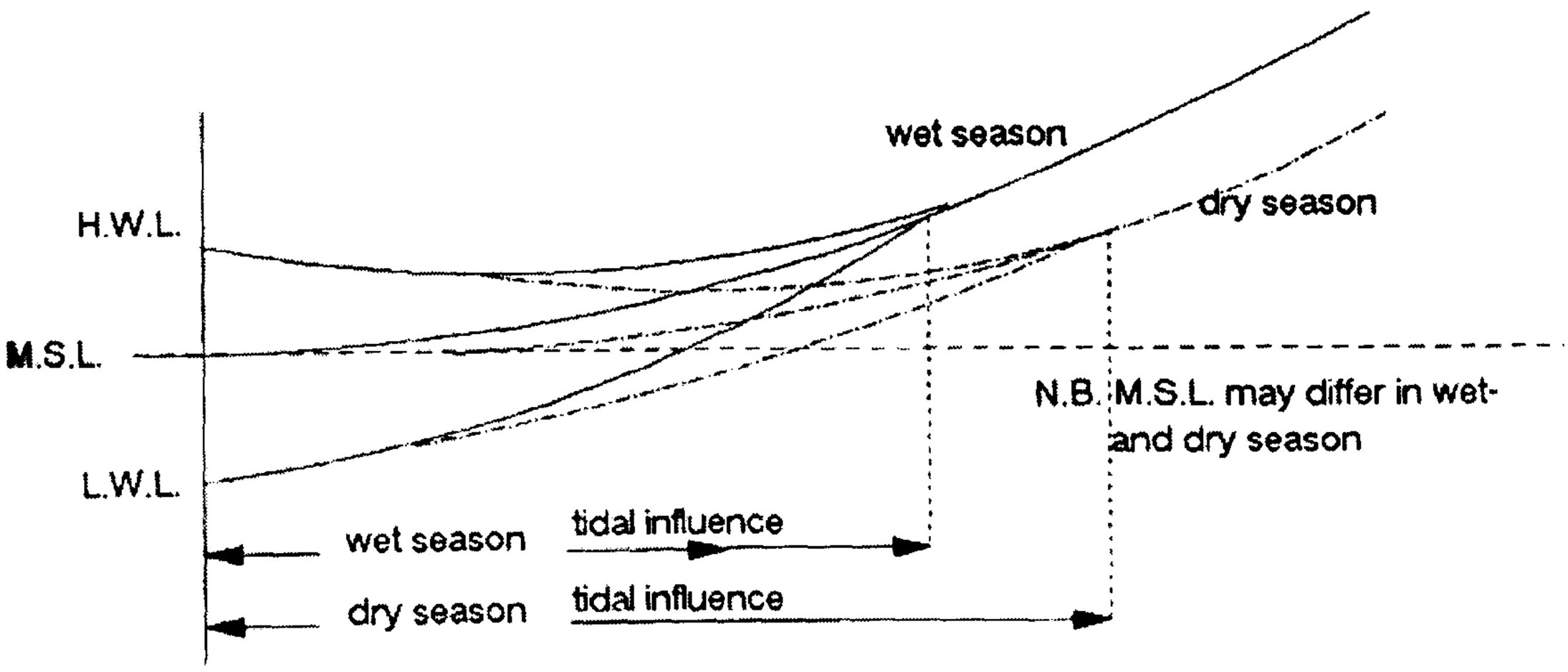

Figure 2.1 Effect of Upland Discharge (**Source**: *Principles of lowland development in Indonesia)*

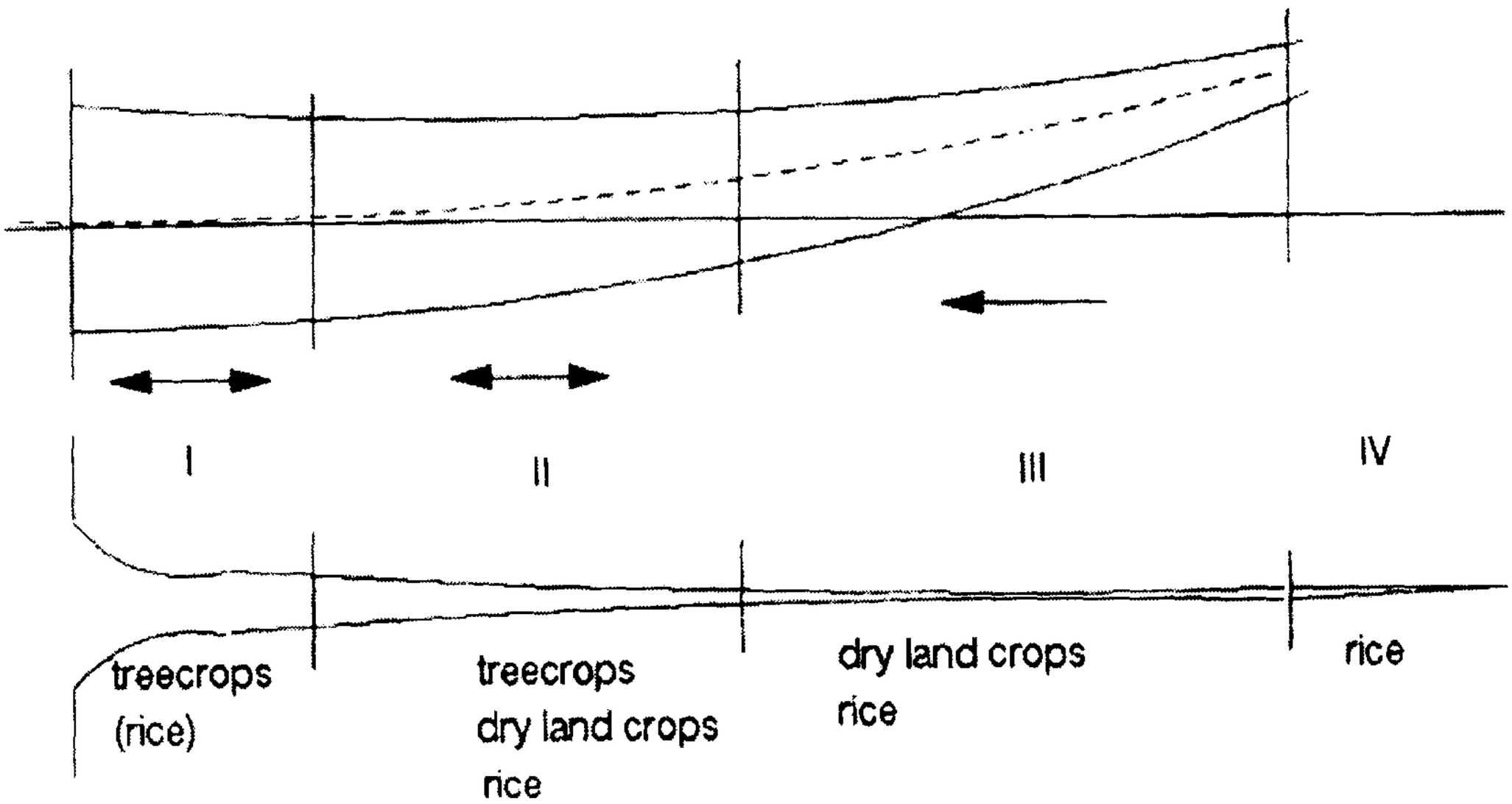

Figure 2.2: Characteristics of River Reaches (**Source**: *Principles of lowland development in Indonesia)*