telaah pustaka

CONCEPTUAL APPROACH ON DEVELOPMENT OF TIDAL FARMING FROM WATER MANAGEMENT ASPECT

A Case Study at Kalimantan, Indonesia**)

by :

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ABSTRACT

A lot of tidal irrigation land development projects were carried out in several locations of Kalimantan for new settlement and food production.

A continous research has been conducted to develop tidal agricultural land since 1971. Based on the research, a new concept for redesigning and reconstructing of tertiary demonstration block (TDB) should be develop.

A conceptual approach on development of tidal farming from water management aspect has been proposed. The concept is presented in a model named Micro Water Management Model (MWMM). The basic concept of MWMM is improvement of micro water management and then be followed by improvement of all aspects.

Introduction

1.1. Background Information

The Agricultural land of tidal swampy areas in Kalimantan is one of the important areas for new settlements and food production in Indonesia. Up to the present the Government of Indonesia has reclamed of about 250 000 hectare of these tidal swampy areas in Kalimantan to be developed as a new agricultural land.

The main objectives of tidal swampy area reclamations project are : a) to increase the arable agricultural land for food production, particularly rice, b) to create a new job opportunity in agricultural sector to overcome the excess of man power in overdensely populated

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regions like Java and Bali. c) to start the preliminary stage of regional as well as national development, and d) to create stability of natural defence and military strategy reason.

A lot of tidal irrigation land development projects were carried out in several locations of Kalimantan. The design of the canal system of the tidal irrigation system is awarded to the Gadjah Mada University (GMU). The university designed two types of canal network systems. The first one has a shape as a fork and it called as ''Tidal Irrigation Fork System''. The second one has a shape as a comb and therefor is called ''Tidal Irrigation Comb System''. Each unit of irrigation system has an area of about 3,000 — 4,000 hectares. Figure 1 and Figure 2 show the system while demensions of the canals is presented in Table 1.

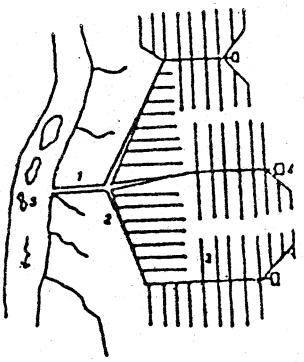


Figure 1. **Fork Type of Gadjah Mada University Canal Network System. 1. primary canal; 2. secondary canal; 3. tertiary canal; 4. food tide pond; 5. tidal tiver.**

Eventhough the projects were carried out for more than 10 years ago, some improvements in design and management are still needed especially in tertiary system. The factors which have hampered the improvement of the system are :

a. cultivation method in tidal agriculture land is unknown
b. poor water regime
c. toxic soil and poor water quality for crops
d. crop pests and diseases
e. poor water quality for domestic use
f. management and social aspects

(Anonymous, 1977; Arif, 1984).

To solve the problems, the Government of Indonesia in collaberation with GMU have been conducting a comprehensive research on tidal agricultural land development since 1971.

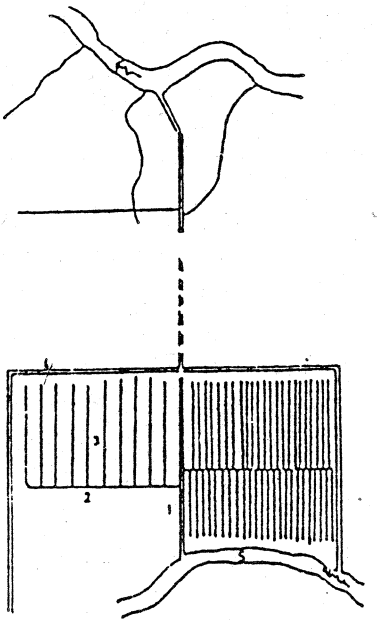


Figure 2. **Comb type of Gadjah Mada University Canal Network System. 1. primary canal; 2. secondary canal; 3. tertiary canals; 4. collector canal; 5. tidal river.**

1.2. *General Discription of Tidal Irrigation Projects*

Some tidal irrigation projects were developed in South and Central Kalimantan in Barito — Kapuas — Kahayan Watershed, approximately 25 — 50 km upstream from the river mouth of Barito, Kapuas and Kahayan. In West Kalimantan, land reclamation takes place in Kapuas Watershed, approximately 25 km upstream from the river mouth of Ambawang and Punggur Besar. The topography is nearly flat and about 1 m above mean sea level.

The mean annual rainfall in South and Central Kalimantan is about 2,000 — 3,000 mm. Normally the maximum monthly rainfall is about 300 — 400 mm, and the minimum is about 40 — 50 mm occurs in August. In West Kalimantan, the mean annual rainfall is about 3,000 — 3,500 mm. These rains are evenly distributed throught the year with monthly rainfall is about 200 — 300 mm.

The temperature is almost constant all the year. The mean daily temperature is 27,3°C. Main daily relative humidity is 90,8 percent.

Most of the soils in the projects area clay soils with a peat soil layer on top of it. The thickness of peat layer varies from less then 25 cm up to more than 150 cm. According to the thickness of peat layer there are two types of peat soil; Histosol with a thickness of peat layer less than 25 cm and Inceptisol with more than 25 cm thick. The pH is arround 4.0 — 6.0. After being reclaimed, the soil is quite acid with soil pH arround 4.0 — 4.5. Some parts of the areas pyrite content in the clay soil is considerably high. This material if it exposed becomes extremely toxic for crops. Therefore, it must be kept away from the root zone. Flooding of the field or maintaining the pyrite layer under saturated condition is the best way to avoid exposure of pyrite (Anonimous, 1974).

Tabel 1. **Demensions of each canal and tide pond (m).**

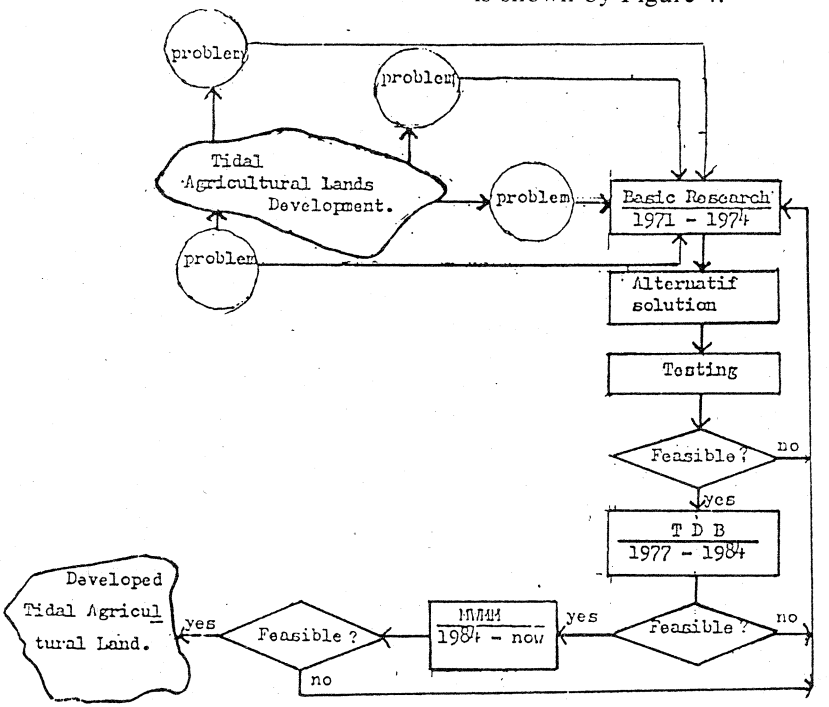
No. Type	primary	secondary	tertiary	tide pond
A. Fork Type				
1. length	1000 — 2000	5000 — 6000	1000 — 2000	300
2. width	40 — 60	20 — 25	1 — 1,5	300
3. depth	3 — 4	2 — 3	1 — 1,5	1
B. Comb Type				
1. length	1000 — 2000	5000 — 7000	1000 — 2000	no tide pond
2. width	20 — 40	15 — 25	1 — 1,5	
3. depth	3 — 4	1 — 2	1 — 1,5	

2. Tidal Agricultural Land Development Research Approach

Research activities have been coducting to develop an appropriate technology of tidal agricultural land development. These researches are carried out in some experimental station located in South, Central and West Kalimantan.
The whole steps of research activities in tidal land development is presented in Figure 3.

2.1. The Basic Research

The Basic Research as shown in Figure 3. concerned with problem identification, formulation, and finding out the alternative solution in many aspects of agricultural production system in tidal areas, especially to those problems wich are suspected arise in the new agricultural land. The alternative solution either might be inform of an individual solution or a blend of many aspects solution. These solution are considered as first stage of developing new technology in agricultural production system in tidal agricultural land. The basic research is organized and administered called as Test Farm. Specifically in Gadjah Mada University this institution is named as Test Farm Gadjah Mada University with memberships come from many different field of sciences which have connection in the agricultural land development problem. The general activities cover in basic research of agricultural land development is shown by Figure 4.



TDB : Tertiary Demonstration Block
MWMM : Micro Water Management Model

Figure 3. **Research steps of tidal agricultural land development.**

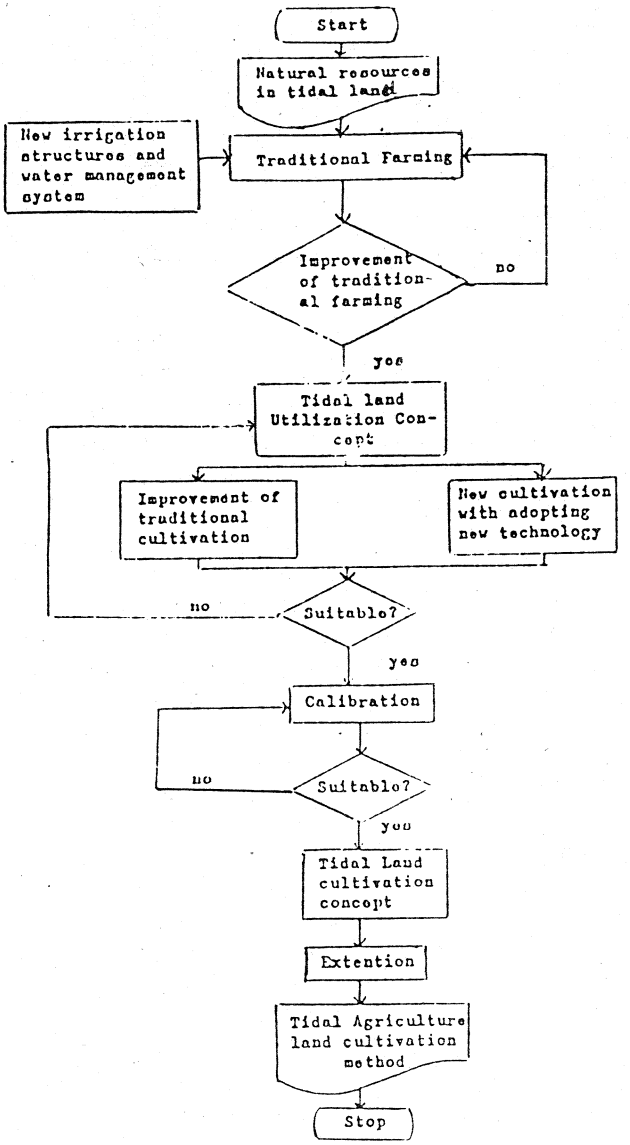


Figure 4. **Activities of the basic research in tidal agricultural land development (Anonymous, 1984).**

2.2. *The Tertiary Demonstration Block (TDB)*

Firstly, the TDB was defined as a group of rice field which water regime is controlled mainly by tidal tertiary canal. The tertiary canal has function either as supply or drainage canal or both. (Anonymous, 1977).

Under controllable water regime rice is expected cultivated twice a year. In the real condition the expected paddy land cannot always be achieved. Also the asumption that water management system at the TDB independent to the whole water management sysem is not correct. The TDB had an areas of about 50 ha represent a full scale of test field. Farmers whose their land in the TDB are encouraged to participate the implementation of TDB program. From 1977 up to 1983 the TDB had been carried out in some tidal irrigation project Kalimantan for examples in : a) South Kalimantan are Barambai (1977 — 1979), Belawang (1982 — 1983) and Tabunganen (1982 — 1983); b) Central Kalimantan are Tamban Luar (1977 — 1982), Sakalagun (1983 — 1984), Terusan Tengah (1982 — 1983); c) West Kalimantan are Bintang Mas (1980 — 1984), Pinang Luar (1981 — 1984) and Air Putih (1981 — 1984).

Design examples of the improved tertiary canal of the TDB are presented in Figure 5.

During the TDB activities, it was observed that tidal motion in some tertiary canals were not strong enough to performe either as irrigation or drainage system. Also the canal system excert a considerable dumping effect to the tidal motion in such away that the amplitude of diurnal tide decreases rapidly toward the upstream. Therefore irrigation water could not overspill to the field as planed by the original design. As a result the edge of tertiary block usually could not be irrigated or drained properly. If the tertiary block had a drainage problem, then the field became submerged. If this happened for long time the water would become toxic for the crops.

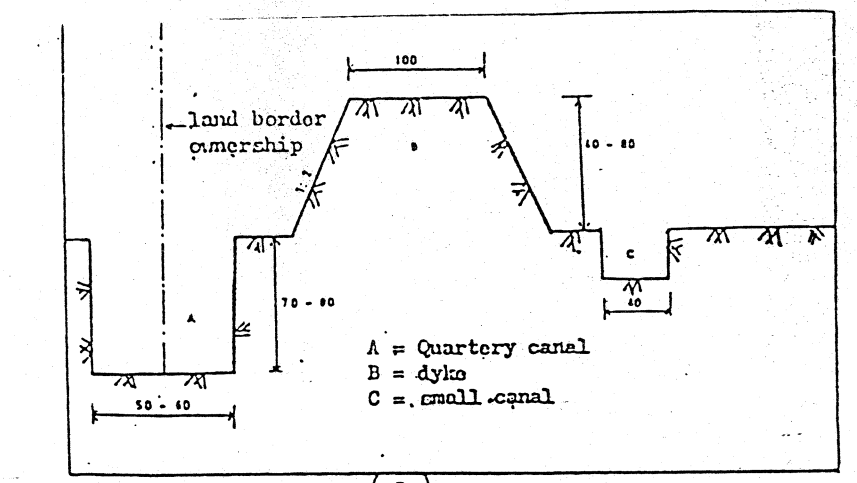
Table 2. shows the specific problems in some TDB during the activities.

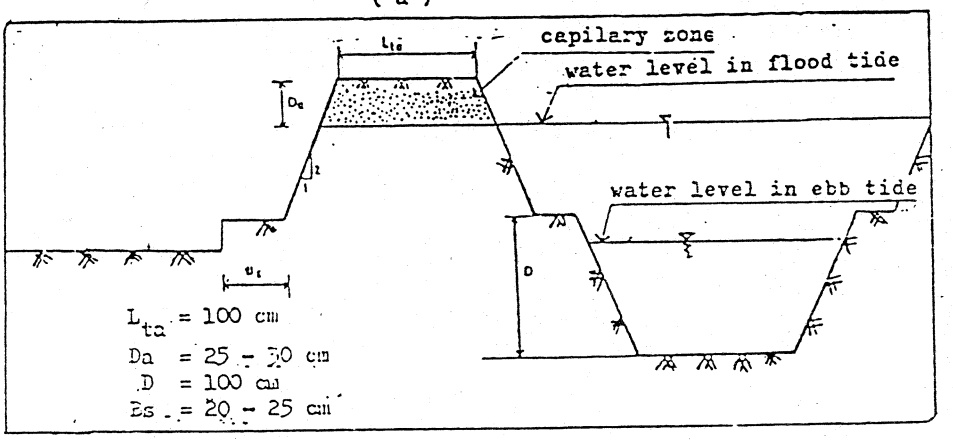
2.3. *The Micro Water Management Model (MWMM)*

To solve the problem as previously mentioned, the new consept for redisigning and reconstructing the TDB should be developed. The new concept for redesigning and reconstructing the TDB based on system approach. It is assumed that a TDB is a subsystem of the whole unit land development, consist of several subsystems. A simple diagram of the process analysis is presented in Figure 6.

Figure 6 shows the general systematically process of redesigning and reconstructing of TDB utilzing analysis sistem. The TDB as one component of the unit is modelled named : Micro Water Management Model (MWMM) and has a closed system characteristic. Refering to Figure 4. and Figure 6. it is obvious that the TDB has a strong lingkage with basic research. The TDB is also representing the following step of basic research in land development carried out by Test Farm, in which results from basic research is synthesised to be a new technology of agricultural farming system in tidal land areas.

The MWMM considers the improvement of water management at tertiary block is the key factor for improving far-





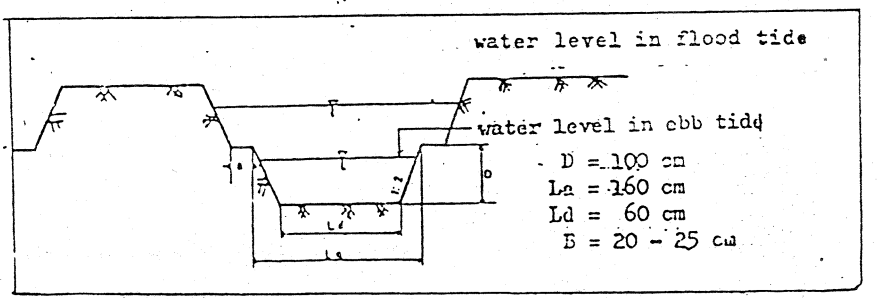


Figure 5. **Design examples of the improvement tertiary canals of the TDB**
(a) Quartery canal and dyke of quartery canal cross section
(b) dyke of tertiary canal cross section
(c) improved tertiary canal cross section.

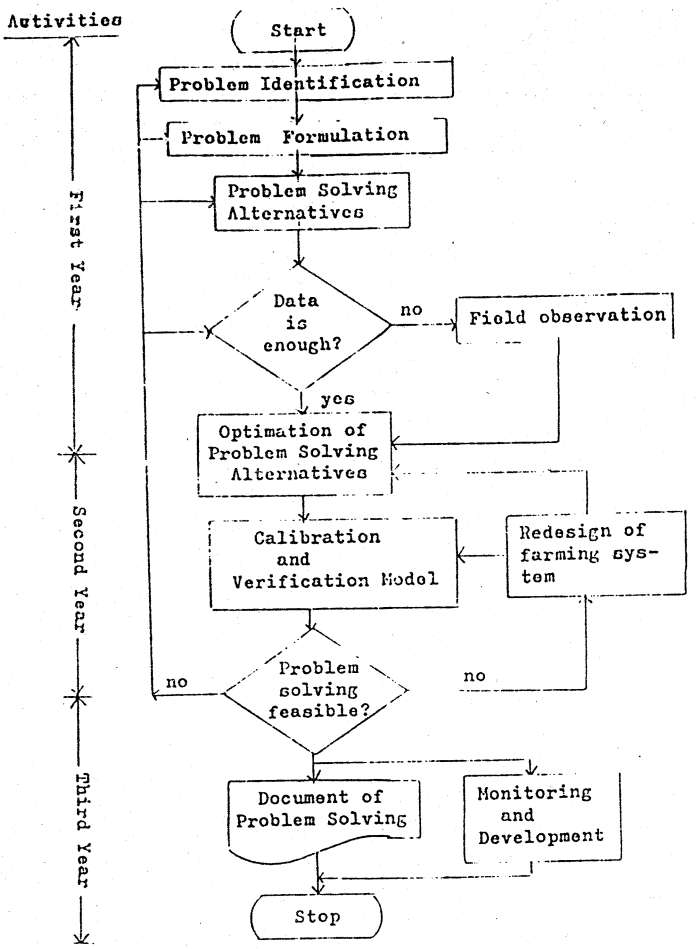


Figure 6. **Configuration of The TDB Development Analysis.**

No	Specific problems	South Kalimantan			Central Kalimantan		West Kalimantan	
		Barambai	Belawang	Tabunganen	Tamban - Luar.	Terusan Tengah	Bintang Mas	Teluk Bateng
1.	Tide influence to surface water regime in the TDB	floaded	unflooded	unflooded	flooded and unflooded	flooded and unflooded	unflooded	unflooded
2.	Water quality	acid	acid	acid and high soliinity	acid[4)]	acid	acid	acid and soliinity
3.	Drainage	yes	no	no	yes	yes	yes	yes
4.	Adapting agricultural new technology	paddy land development.	upland crops development	upland crops development with salt control	paddy and upland crops development	paddy and upland crops development	upland crops development	upland crops development with salt control
5.	Soil - peat soil thickness	< 50 cm	50-100 cm	50-100 cm	50-150 cm	50-100 cm	> 150 cm	> 150 cm
	- potential cat clay	no	yes	no	no	no	no	no

Sources : Research and Development Report of Water Regime at the TDB of Tidal Irrigation Project in South, Central and West Kalimantan (1977-1984)

Tabel 2. **The specific problems in some TDB during the activities.**

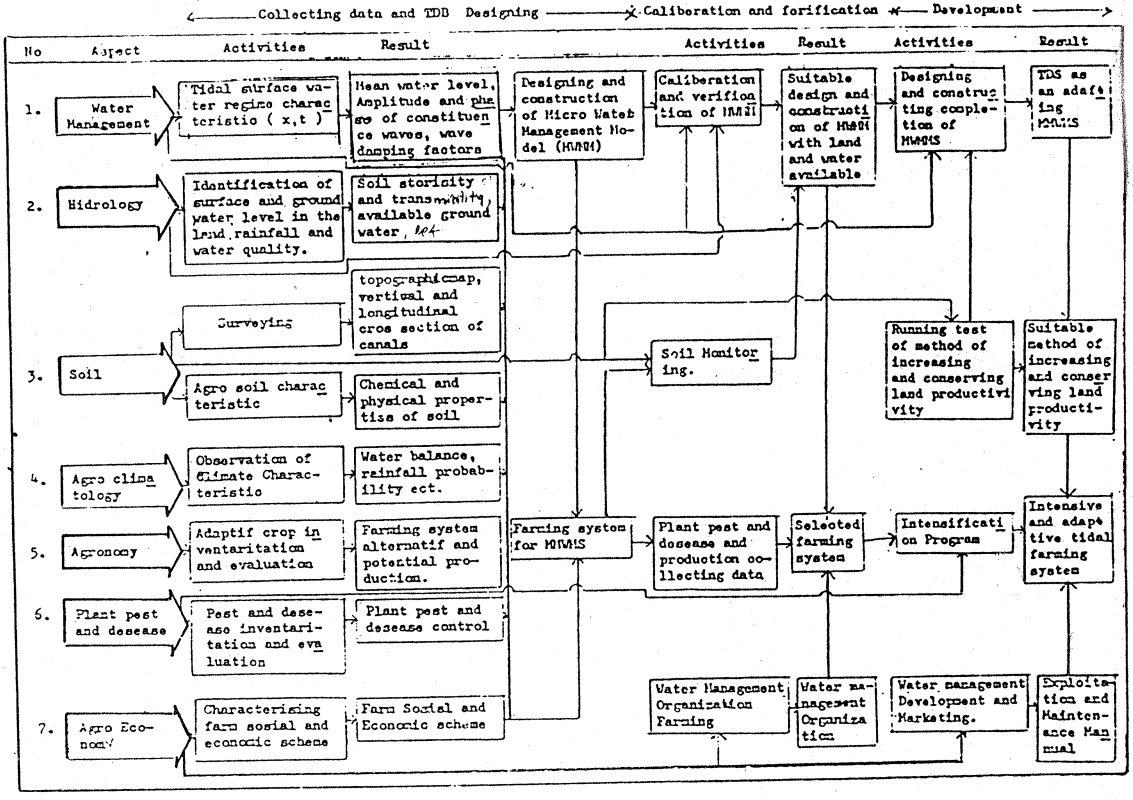


Figure 7. **Linkage of components of the**

ming system as a whole. Water management at tertiary block must be improved first enable any other agricultural production inputs can be incorporated into production system within optimum benefit. Figure 7. shows the detail components of MWMM. So far there are already 7 models of MWMM available with problem spesifications are listed in Table 2.

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