Land remodelling in Tung Kula Ronghai region of Northeast Thailand

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1 Introduction

This paper describes the background and constraints that have caused the Tung Kula Ronghai (TKR) to be one of the most depressed areas in Thailand, followed by a description of the concept of Land Remodelling, and how this solution is being adopted to overcome many of the natural constraints of this area to provide an improved environment for rice cultivation and reduce the probability of crop loss caused by flooding and droughts.

2 Tung Kula Ronghai and its problems

2.1 General

Tung Kula Ronghai ('Plain of the weeping Kula people') comprises a low-lying area of 3370 km^2 in the centre of the large basin-shaped Korat Plateau of northeastern Thailand (Figure 1). The area had been settled only recently due to population pressure in other areas of the Northeast. The present population amounts to about 400 000 inhabitants (density 120/km^2).

2.2 Topography

The Tung is drained by the Nam Mun river which flows in eastern direction to the Mekong River and a number of smaller tributaries, such as the Lam Sieo Yai, and Lam Tao, flowing through the Tung from north-west to east. Run-off from the upper catchments of these rivers is discharged into the Tung causing frequent and prolonged flooding (Figure 1). In an average flood year significant parts in the Tung, usually strips of 2-5 km wide along these rivers are inundated. The areas between the rivers are extensive alluvial plains with occasional sand ridges which rise to about 20 m. These alluvial plains are extremely flat with little natural relief and very low gradients (average 1:15 000). Therefore direct rainfall on these plains is drained by overland flow (from paddy field to paddy field) for many kilometres causing a very slow evacuation of excess water.

2.3 Climate

The climate of the Northeast is classified as Tropical Savanna type, according to Köppen's Climatic Classification (Griffiths 1978). Three seasons can be distinguished: the rainy season, the winter season (cool) and the summer season (dry and hot) (Meteorology Dept. 1977). These three seasons are influenced by the Southwest and the Northeast monsoons. About 80% of the annual rainfall of 1300 mm falls from May to October. However, the distribution of this rainfall is highly variable. The wet season rice production is adversely affected by dry spell periods of 2-6 weeks which commonly occur in June and July as well as excessive rains in August and September which causes flooding. Evaporation greatly exceeds precipitation from November to April and the temperature rises markedly in March and April. There are no prospects for dry season cropping due to the absence of irrigation water.

2.4 Soils

The soils of the Tung are sandy, and with a low natural fertility. They have a poor waterholding capacity and tend to dry and crack quickly during dry spells if insufficient water is empounded on the fields as a stored supply to last over the dry period. Saliniza-

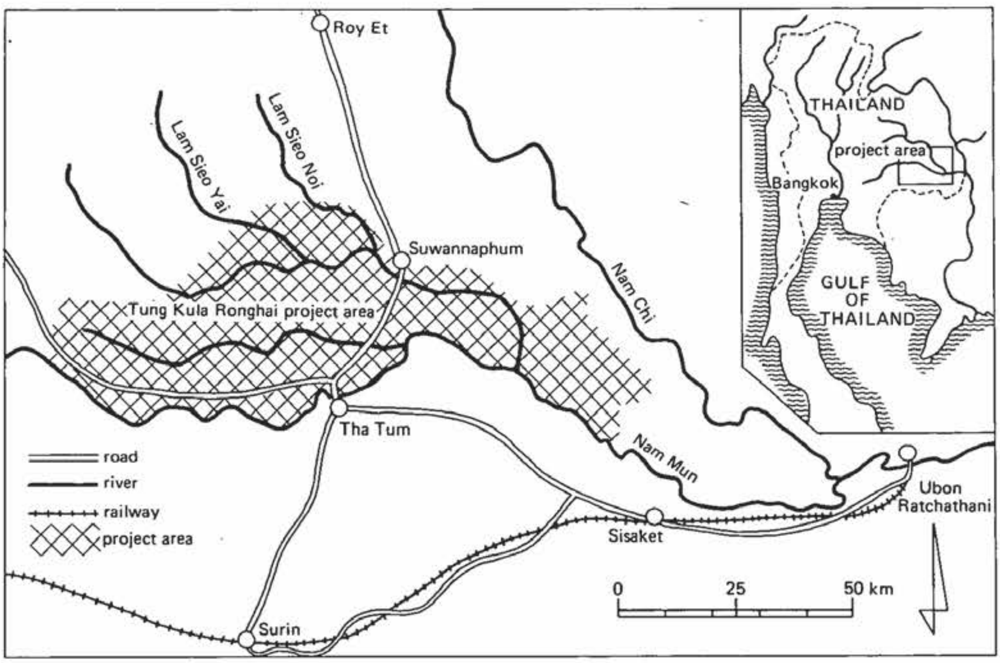

Figure 1 Location of Tung Ronghai area in Thailand

tion is an increasing problem, even for rice production. Therefore improved water control, fertilizers and additional organic matter are of vital importance for improving rice yields.

2.5 Water resources

The water resources of TKR also restrain development. Because of the flat topography there is limited potential for large scale storage of wet season surface flows for dry season irrigation. Quality and quantity of the groundwater is variable and therefore also has limited potential.

2.6 Farming

The dominant farming activity (approximately 80%) in TKR is rainfed wet season rice production on the lowlands. Other activities include fishing, buffalo, cattle, poultry and pig keeping. Average farm size is about 4 ha. The difficult environment inhibits agricultural production and depresses income causing the people in TKR to be among the poorest in Thailand. About 60% of the families relies on off-farm work to supplement their incomes.

3 Project background

Land remodelling is a component of the Thai-Australian Tung Kula Ronghai Project (TATKRP). TATKRP is a multi-component, integrated rural development project funded jointly by the Royal Thai Government and the Australian Development Assistance Bureau (ADAB) which aims to overcome some of the problems and uplift farmers' incomes. Technical assistance is being provided by an Australian consulting firm, McGowan Intern. Pty. Ltd.

Implementation of the land remodelling component has been undertaken by the Engineering Division of the Department of Land Development (DLD) of the Ministry of Agriculture and Co-operatives. Construction started in 1983 and in its present 5 year phase the project is regarded as a pilot implementation project aimed at researching and refining the appropriate techniques. A total of 12 000 ha will be constructed during this phase which is only 10% of the potential land remodellable area in TKR. This phase is scheduled to be completed in 1989 after which the rate of development is expected to accelerate.

4 Land remodelling concept and benefits

Land remodelling is a system of controlled drainage to improve in general the environment for wet season rice cultivation and more specifically, it aims to reduce the probability of crop loss caused by flooding and drought.

It consists of the construction of a network of drains to improve the drainage capability of the area. These drains are provided with check structures designed and located in such a way to prevent overdrainage, while at the same time they allow the controlled passage of flood water. The check structures also provide water storage for supplementary irrigation. This concept can be applied to poorly drained alluvial plains where slopes are flatter than 1:10 000.

The operation of the system can be illustrated by comparing rainfall distribution and crop water requirements (Figure 2). Some remarks are:

- The volume of water stored for irrigation is limited but is sufficient to at least ensure supplies for rice nurseries which occupy only 5 to 7% of the cultivated area. Water shortages normally coincide with the nursery stage of the rice crop;
- The drainage facilities provide flood mitigation due to faster evacuation of direct rainfall on the alluvial plains but do not protect against flooding from the rivers. The development is generally confined to areas above the influence of the 1 in 5 year river floods.

Figure 3 shows the estimated crop yield benefits expected from the improved water management capabilities provided by the land remodelling system. It is based on an

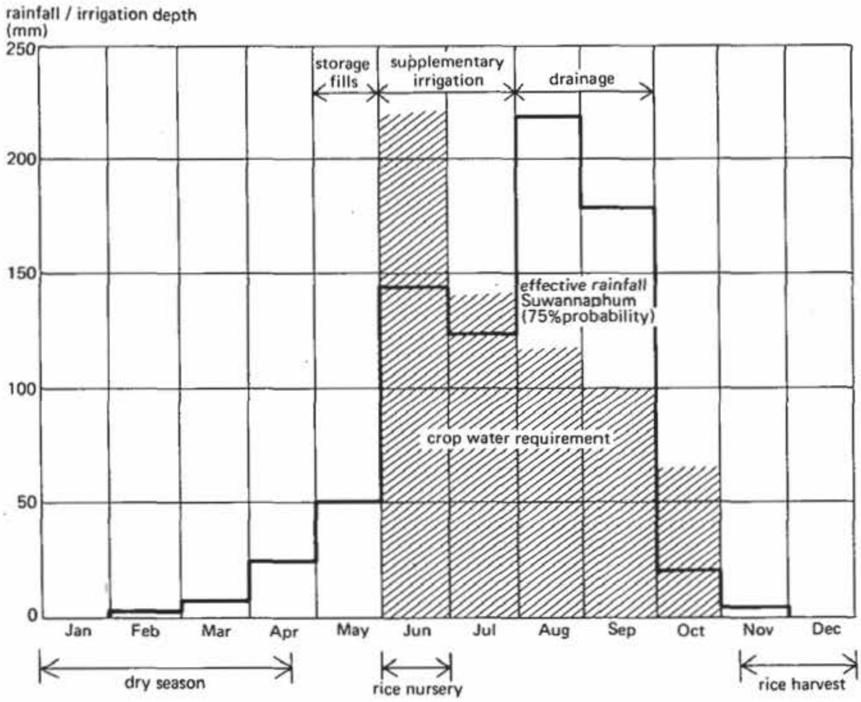

Figure 2 Illustration of the operation of the land remodelling system

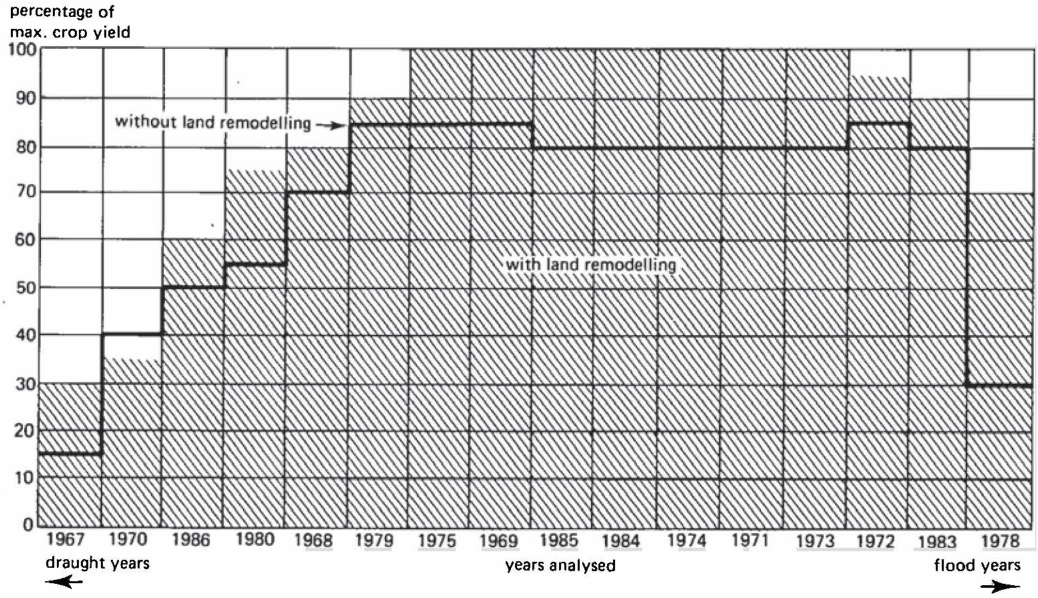

Figure 3 Estimated crop yield benefits from land remodelling
Note: 100% crop yield indicates that the crop did not suffer from either flooding or water deficit

analysis of the field moisture conditions during the cropping season which were simulated from historical daily rainfall occurrences. Also it takes into account the systems ability to provide supplementary irrigation when there is a water deficit or to drain adequately fields when there is excess water. It was assumed that there will be a 100% crop yield when the crop does not suffer from either water deficit or excessive flooding. Although land remodelling development is expected to improve crop yield in other ways too (e.g. more crop inputs, better farming practices, etc.), these are not included in the estimated crop yield benefits. From improved water management alone, average crop yields are expected to increase by about 20%.

Land remodelling also provides a number of additional benefits. The most significant of these is the provision of access into the rice growing areas. Wherever a drain is constructed the excavated soil is used to construct a farm road. While the benefits of the improved drainage are only enjoyed in years of flooding, the benefits of the farm roads can be noticed every year. These roads make it possible for farmers to enter the areas during the wet season with fertilizer, machinery and labour which is impossible without land remodelling development. Farmers normally live away from their farms in villages or towns and commute. At present farms are better attended because it is more convenient for farmers to commute daily by bicycle or vehicle whereas before it meant a long walk. There is also an increasing tendency to construct houses on the farm. Further benefits are derived from the expanded fish habitat and the drains provide a route for fish to enter the ricefields where they can breed and grow. A final benefit of the introduction of a network of drains is the possibility to divide rice growing areas into separate definable units which will greatly assist in extension and development assistance provided to the farming communities.

5 Land remodelling design

5.1 Design criteria

Drains are located at approximately 1 km spacing so that every farm is within 500 metres of a drain (and road). A typical cross-section of these drains is shown in Figure 4.

Sizes of the drains and associated structures are selected to allow evacuation of the 1 in 5 year 3-day peak rainfall (200 mm) within 6 days (3.8 l/sec.ha), based on the assumption that the rice plant can generally tolerate flooding up to 6 days without serious yield reduction.

5.2 Lay-out

Lay-out of the drains is determined from a study of cadastral maps, natural land formations, and drainage patterns. Orthophotos of 1:10 000 scale with 0.1 m spot levels are used to assess topographic features. Natural drains, where they exist, are incorporated but lay-out is severely constrained by land ownership boundaries which sometimes reduces the efficiency of the design. However, because of the flatness of the area (level variations generally within 10-20 cm), this is not a serious handicap.

5.3 Cells

The land is divided into units of approximately the same natural land level. These units are called 'cells'. They vary in size from 600-1500 ha depending on the relative flatness of the land. Weirs are constructed at the outfall of each cell and have the crests set at 30 cm below the average field level to prevent overdrainage. Given the

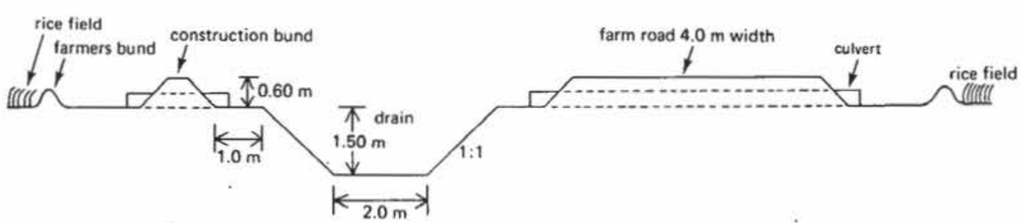

Figure 4 Typical cross-section of drain, farm road and bunds

vastly improved drainage capabilities, it is important to control the rate of outflow to prevent excessive flooding in the downstream cells. The weirs are designed in such a way that they regulate automatically excessive outflows by surcharging to the extent that they impede run-off from the fields. This effects the distribution of flooding at shallower depths over a larger area in a number of cells.

As land remodelling develops within an area, a great number of cells are built up, each at a different level. Each cell passes its drainage water to the cell below it and the lowest cell passes the water to the river system. The system is similar, only on a much larger scale, to what is seen in rice fields where water passes from one field to another field downstream. Naturally, the lower cells require larger drains than the upper cells as they have to carry more water. The cost of cell construction therefore increases downstream towards the rivers. The development within a subcatchment is in an upstream direction.

5.4 Cell systems

In accordance with the process of research intended during the pilot implementation phase of the project, variations in design are being tested. In particular two cell systems with significant conceptual differences are under study at present.
Figure 5 illustrates the different lay-outs of the two systems:

a. Open-cell grid drainage system. This was the first system adopted and this concept is applied in all constructions up till now. All drains within this cell system are interconnected on a grid pattern with escape weirs and equalizing pipes provided at the cell boundaries. The network allows flood water to distribute itself in the cell and find its own level. Water may also enter or leave the cell by weirs and culverts in response to the relative water levels. Due to the low relief in the land surface there may also be flow across subcatchment boundaries. Because the quantities and directions of flow in the drains could not be easily assessed, drains were oversized to offset the lack of detailed knowledge. It became apparent that a more detailed study of the catchments serviced by each drain was necessary to refine designs which led to the development of the 'closed-cell trunk/branch drainage system.
b. Closed-cell trunk/branch drainage system. Present designs adopt this concept. In this system, cells are closed at their boundaries and connected only by a trunk drain running through a series of cells within a defined catchment area. Smaller branch drains enter the trunk drain laterally to drain each isolated cell. In this way the catchment area for each trunk drain can be determined accurately and hence hydraulic design of structures can be refined. This approach has enabled a reduction in drain dimensions and therefore reduced costs.

5.5 Monitoring designs

A data collection network to record water levels and rainfall has been established to monitor hydrological and hydraulic performances of the systems. In this way advantages and disadvantages can be assessed and designs refined accordingly.

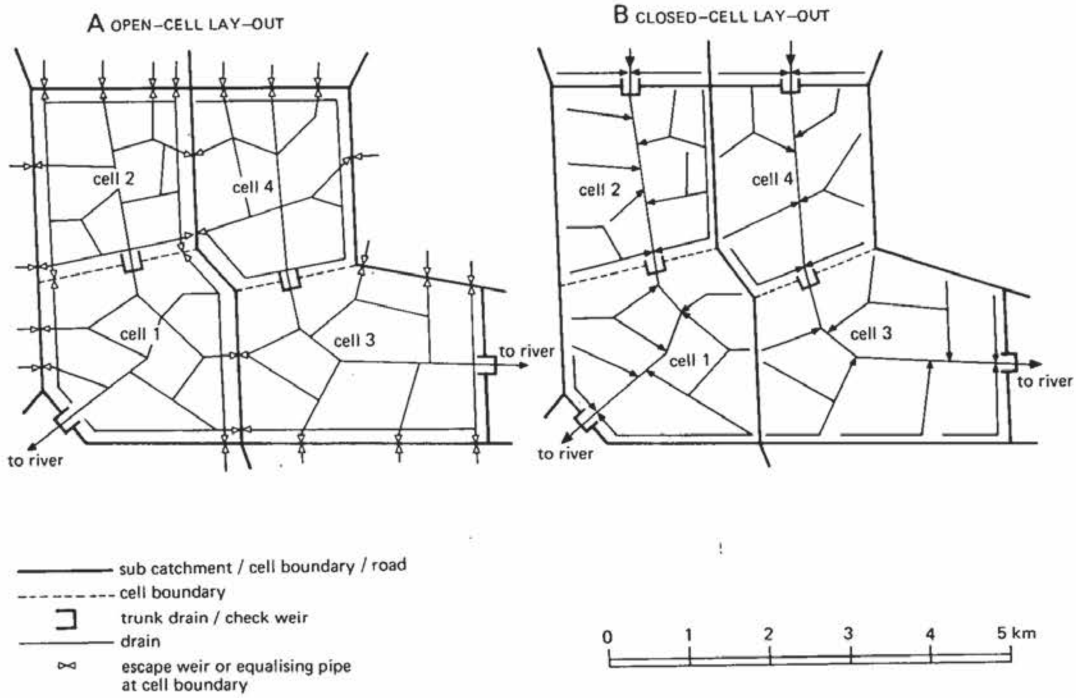

Figure 5 Different lay-outs of cell system

6 Land remodelling construction

Construction of land remodelling can only be carried out during the dry season. This reduces the construction season each year to the period between January and April. The main tool for construction of the drains is a hydraulic excavator which is fitted with a special trapezoidal bucket made to the size of the drains being constructed. With a 100 kW hydraulic excavator it is possible to dig over 500 metres of drain per day. Roads are constructed by trimming the spoil from drains with a bulldozer and compacting the top layer with a sheep-foot roller. Although this provides only a relatively low standard road, they are adequate for normal farm traffic.

7 Land remodelling costs

Construction of land remodelling started in 1983 and at present there are some 5800 ha operational. Average construction cost to date is US$ 200 per ha.

8 Land remodelling extension

Support from other government departments is an integral part of land remodelling development to ensure that maximum benefits are extended to farmers. The Department of Agriculture and Land Development has crop research programmes focussed specifically on land remodelled areas. The Department of Agricultural Extension assists by demonstrating farming techniques which capitalize on the improved water management facilities. The Department of Fisheries is also active in the area studying the effect on fish migration and providing stocks of fingerlings for drains. In addition, the Community Development Department is in the process of identifying community needs and assisting coordination of support groups for scheme management.

9 Conclusion

Results of a baseline socio-economic survey, conducted by Khon Kaen University in December 1985, show that the effects of land remodelling are well accepted by most farmers. Farmers also claim that they have experienced less flooding and that they use the stored water for supplementary irrigation. However, climatic conditions up till now have not been severe enough to demonstrate obvious yield increases. Nevertheless the farming community says that they benefit by the development and that they are especially pleased with the improved access roads and increased fishing opportunities.

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