Irrigation in the Humid Tropics
Project Design Issues in Indonesia and Thailand

Opinions vary about the role public irrigation has played in the dramatic increases in rice production achieved by Indonesia and Thailand over the last two decades, and, for the future, about what role public irrigation schemes should be expected to play in achieving food security in the rice-growing tropics.

Two audits by OED* remain agnostic on these questions, but they stress how powerfully Bank lending has been influenced by belief in a direct causal link between public irrigation investments and increased rice production. They note that large resource transfers for irrigation, followed up with almost no monitoring of project performance, have perpetuated the use of unsuitable engineering designs, operating under circumstances where they cannot work.

Neither Indonesia nor Thailand has succeeded in making public irrigation systems work as designed. From detailed observation of how projects have operated in practice, the audits draw recommendations for the design of future irrigation projects in the humid tropics.

### Indonesia

Over two decades the Bank has financed 21 irrigation operations in Indonesia, for about $2 billion (1987 prices). The motivating force for Bank irrigation lending through the mid-1980s was Indonesia's push for self-sufficiency in rice, which was achieved in the mid-1980s.

The tenth, fourteenth, and fifteenth operations reported on here were appraised in 1977-79 and completed in 1984-87. They covered nine separate irrigation subprojects affecting more than 380,000 ha., almost all of which were to rehabilitate or expand existing irrigation/drainage systems. Irrigation X was to upgrade two run-of-river schemes in Lampung, Sumatra, to storage irrigation schemes, by building dams, and to rehabilitate the Kali Progo run-of river scheme on Java. Irrigation XIV financed four second-generation run-of-river projects on Java. Irrigation XV was for the completion and expansion of two run-of-river schemes in northern Sulawesi.

**Implementation**

Irrigation XIV and XV were implemented as designed; economic rates of return (ERRs) based on plausible assumptions about future cropping intensity, yields, and useful life at project completion were satisfactory, at 14-30 percent for the various components.

Parts of Irrigation X, in Lampung, show how things can go wrong when the goal of transferring resources dominates over economic and technical considerations. Plans for the storage dams for the Sumatra subprojects were dropped when it was shown that their construction would be more difficult and costly than appeared from the feasibility study.

Without these dams, the two revised run-of-river Sumatra components had ERRs of only 6 and 9 percent at completion — under very favorable assumptions about the impact of the investments. The Kali Progo component proceeded broadly as planned; its ex post ERR was 17 percent.

A 1987 study by the International Irrigation Management Institute (IIMI) documents how Indonesian public irrigation systems actually work. There is little resemblance to original design assumptions. Bank-financed tertiary canals have disappeared in areas that never receive water during the dry season or during a wet season drought, reinforcing other evidence that the actual command areas of run-of-river schemes are much smaller than designers expected.

The plausible assumption problem in Indonesia

In Indonesia the relationship between investments in public run-of-

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Mae Klong Sugar

In the Mae Klong project in Thailand, the relatively well-off and subsidized sugarcane farmers on the river’s left bank were not the target of the Bank’s lending effort which was designed for the less well-off and taxed paddy farmers in the area. Thus though it did provide public outlets from which cane farmers could take water, the project did not provide tertiary canals and drains for these farmers as it did for the paddy farmers.

In the end, about 7,300 ha of sugarcane benefited from the Bank-supported investments. The cane farmers were already using tube well irrigation which they financed themselves before the project but they welcomed the provision of free surface irrigation water in the dry season because it saved them money. Rather than construct their own tertiary canals to “command” the cane fields, however, the cane growers chose to drop the water from the public outlets into ditches leading to their fields. From the ditches they pumped it with low-lift pumps to the furrows as required. Embankments, compaction, and field outlets were not needed.

By contrast, the engineering approach used for the poorer paddy farmers was contentious from the outset, because of the issue of land acquisition for tertiary canals, and once installed it did not operate as designed.

The main implementation problems in both these operations stemmed from farmers’ lack of enthusiasm. In the Mae Klong, about 38 percent of the farmers to be affected did not want or could not agree on the proposed tertiary canals, whose construction required them to give up farmland without compensation, and to trust they would ultimately benefit from the works. In the Pattani scheme the farmers at first did not want any on-farm development; building trust has required more time and effort than building canals.

ERRs calculated at project completion were 7-8 percent in Mae Klong and around 5 percent in Pattani. Rice prices (world and farm-gate) are too low to encourage the replication of such projects nowadays.

The hypothetical assumption problem in Thailand

Here, as in Indonesia, farmers damage and in effect redesign the systems. The technical paradigm takes little account of the indigenous development and use of axial flow low-lift pumps—all financed by farmers—roughly a million of which now deliver water to fields in the dry season from canals, drains, ditches, and ponds.

In the Mae Klong project, for example, the manually operated, extensively-gated technology chosen was not suitable for the relatively high wet-season rainfall nor for the rent-seeking environment created by the government’s free water policy (see below). A much less costly extension of the “spreading” infrastructure already in use, without the gates and without the high canals on fill, using low-lift pumps, could probably have extended irrigation potential to more farmers at a much lower capital cost (see Box).

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**Reasons for poor performance**

The poor operational performance in all the projects audited is typical, in many respects, of large-scale public irrigation schemes in the humid tropics generally. The reasons most often given for poor performance are:

- engineering design—especially the hydraulic instability of extensively gated, manually operated, large-scale systems;
- vandalism;
- poor system administration;
- ineffectual user charges and user groups;
- poor maintenance.

In considering what types of action to take in response, however, one needs to look at these reasons, and the interrelationships among them, in some detail.

**Engineering design**

Most canal engineers concede that conventional large-scale public gated systems in monsoon Asia have not performed well. One response has been to use increasingly sophisticated control structures and automatic feedback technology to make the systems hydraulically stable.

Unfortunately, this technology is just as susceptible to rent-seeking behavior and farmer damage as is manual gated technology, so it is very unlikely to solve the problem of poor system performance. In the Thai projects audited, for example, several of the high-tech elements as have been implemented are being used very differently than their designers intended. Hardly any of the constant head orifice structures have ever been used to measure flows as part of an overall water allocation plan. Those flow-measuring devices that have not been broken by farmers are merely used as costly gates in the on or off mode, and inexperienced gate operators respond to farmer pressures. The same is true of the Romajin weir control structures used in Indonesia.

A structured approach to design is technically and economically cruder than the just-in-time system, but it accepts potential damage by farmers as something to consider in the design of a workable system. (See Box).

**Vandalism? Or rational behavior?**

**Rainfall patterns:** In monsoon areas of Indonesia and Thailand, farmers tend to damage irrigation works after rains fail in the wet season. Since these areas usually receive enough wet season rainfall to grow crops without irrigation, most farmers plant all their land, assuming the rainfall will be normal. When the rains fail, the standing crops are stressed and all farmers want irrigation water at the same time. In the attempt to save their crops, individual farmers will damage the system, blocking or breaching canals and breaking gates. The damage is seldom repaired in time for the next wet season.

Here it is worth noting the important differences from irrigation paradigms taken from arid areas, which are those best known in the irrigation engineering profession. In public irrigation systems in arid areas, wet season rainfall is not generally adequate for successful crops; farmers plant only those fields that have dependable supplies of irrigation water. Operation is less troublesome, since the stressful effect of occasional wet season drought on standing rice is avoided.

Rent-seeking: Economic rents in irrigation are the difference between what the farmer officially has to pay the system for water and what the water is worth to him. Where water is provided nearly free, well-located farmers take all the water they need (and frequently more), without regard to the shortages they may cause for farmers further down the canals. Some of the modifications made by farmers, especially the permanent pipe installations in the canal banks in Thailand, clearly mean the cooperation of the canal authority (rent-seeking by farmers becomes rent-sharing with the canal bureaucracy). What might otherwise be considered episodic cases of rural vandalism or selfishness, that could be dealt with by education and training, may thus be seen as economically rational behavior, to be expected where canal water is heavily subsidized.

**System administration**

Irrigation authorities follow different procedures from those assumed by system designers. They have too little information to implement scientific just-in-time water application procedures, and control structures are almost never used to set predetermined flows. In Java, the reasons cited (in the 1987 IMF report on the dry season in Java) are:

- too few staff;
- measuring structures do not work;
- poor training and motivation;
- decentralized control over water allocation;
- lack of exclusive control over offtake structures;
- prevalence of unmeasured supplemental water supply sources;
- crop types and planting dates differ widely within tertiary blocks;
- tertiary blocks stretch across more than one village, and irrigation inspectors and farmers tend to distribute water on basis of negotiated arrangements.

**User charges and user groups?**

Systems paid for by user charges and under farmers' control tend to perform well. A pricing structure and organized user groups harmonizes interests and sets unambiguous rules, as successful experience with community schemes has shown in a number of countries. However, in the large public schemes in Indonesia and Thailand, cost-based volumetric water user charges are not feasible politically, administratively, or technically. Exhortations from economists for user...
charges to counter rent-seeking behavior and promote economic efficiency have an unbroken thirty year record of non-acceptance in both countries. Also, tens of thousands of small but part-time farmers competing for nearly free but valuable water cannot be organized by a public bureaucracy to perform like those in the small self-financing private schemes.

**Maintenance**

For years, all parties have agreed that timely adequate maintenance is essential to efficient operation of irrigation systems in the two countries, and also that maintenance has remained inadequate, making premature rehabilitation necessary. The main causes of poor maintenance are modifications by farmers. Because these modifications are responses to powerful economic incentives, the usual concern for adequate allocation of maintenance funds misses the point; even if provided, such funds would not solve the problem.

**Conclusion**

For climatic, cultural, political, and economic reasons, free or nearly-free irrigation water and associated rent-seeking behavior by farmers are realities unlikely to be changed. To go on designing public large-scale irrigation systems in monsoon Asia assuming this is not the case is difficult to justify.

The Bank’s typical emphasis on new investment and rehabilitation and its lack of support for costly and difficult impact analyses discourages the re-evaluation of basic design assumptions. But for the future, it may be productive to consider:

- Use of the structured design and operation concept, to promote a more equitable and monitorable distribution of water and to make infrastructure less susceptible to damage by farmers.
- Where water charges are to be low, and the rents accruing from canal water are high enough, integration of privately-owned low-lift pumps into system design. Rather than commanding the fields and avoiding pumping, sporadic private pumping from much less costly lower-level storage canals and drains during wet season droughts has lower public investment and operating costs and may allow extension of irrigation networks to more farmers than otherwise.

These options have implications for equity among farmers. Official engineering designs in principle give every farmer in the command area his fair share of water. In fact, those upstream and those close to the primary and secondary canals always get much more than their fair share. It is likely that accepting this inequity would allow designers to produce a system that is both more efficient and less inequitable than actually exists at present.

Re-evaluating irrigation system design in these ways would require more and different staff time within the Bank for basic research and development. Experience suggests it would probably lead to fewer and smaller but more successful lending operations.

Editor’s note: Audit reports make a point of documenting lift to opinion on the operations reviewed. For both the Indonesia and Thailand audits, Regional criticism of the audit findings has been extensive. In the Indonesia audit (Report No. 7956), Annex II presents the Region’s case. In the Thailand audit (Report No. 9205), the contents of Annex I, plus those of footnotes 57 and 60, reflect the objections of the Region. On the contentious issue of technology, see paras 64–73 of Report No. 9205 for the context and paras 79–82 for qualifications and caveats that are largely a reaction to criticisms by the Region.

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