MAIN SYSTEM CANAL IRRIGATION: CHOICES FOR INVESTMENT AND RESEARCH

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In this paper the objectives of irrigation are taken to include productivity (especially of water), equity (especially in the distribution of water), environmental stability, and low cost. The point of view is primarily that of a social scientist. The focus is on main systems above turnouts (outlets) on irrigation which is jointly managed (Coward 1980: 24) at different levels by a bureaucracy and by farmers. The geographical concern is primarily Southeast Asia, and the sources include papers to the Workshop on Investment Decisions to Further Develop and Make Use of Southeast Asia's Irrigation Resources. The reader will also note evidence from India and may wish to weigh its relevance or otherwise, point by point, to Southeast Asia. The purpose is to discuss choices for investment and research.

Types, Scale and Potential of Irrigation

A basic point of departure is the orders of magnitude of irrigated area under different types and scales of irrigation. Three roughly separable types can be distinguished: jointly managed larger schemes, with which we are concerned, usually over 2,000 ha; communals, where the community or communities themselves alone manage the water distribution, usually under 2,000 ha; and small-scale lift irrigation. A rough sense of orders of magnitude is presented in the table.

Table: Irrigated Areas (million ha) of Different Types and Scale of Irrigation in Southeast Asia

	Jointly managed schemes		Communals	Small-scale lift	Total
Indonesia[1]	4.2		1.2	n.a.	5.4
Malaysia[2]	0.16 (over 10,000 ha)	0.11 (201 - 10,000 ha)	0.04 (200 and less)	n.a.	0.31
Philippines[3]	0.37		0.54	0.13	1.04
Thailand	n.a.		n.a.	n.a.	n.a.
(India[4]	28		8	23	59)

Sources: 1. Bottrall: 1981:17 The 4.2 million ha may be misleadingly high as it includes many quite small systems taking off from river schemes.

2. Taylor and Tantigate 1981a:2 The jointly managed canal systems are probably underestimated as the figure of 0.16 refers only to those over 10,000 ha. Some 0.11 million ha are under schemes between 201 and 10,000 ha.

3. Moya, P: 1981:27.

4. Inferred from various official documents and statements.

n.a. = not available.

Although the categories are not exactly comparable, and the figures should be treated with caution, they do indicate orders of magnitude. The area under jointly managed schemes as a percentage of total irrigation area is perhaps about 70 per cent[1] in Indonesia, 70 per cent[2] in Malaysia, and 36 per cent[3] in the Philippines. It may then be of predominant importance in Indonesia and Malaysia, and are a substantial proportion of total irrigation in the Philippines.

A second point of departure is potential. This has two aspects: potential for new irrigation; and potential for improving irrigation which has already been installed. These potentials vary by country, region and system. The sources available do not indicate estimates of potential for new irrigation. Discussion on that point must therefore be somewhat general.

Basic Investment Choices

Three types of investment in main system canal irrigation can be distinguished: new projects; rehabilitation; and management.

i. new projects.

There are choices whether to have new projects, and if so which sorts and where, and how quickly to have them. Past performance may provide some guidance. Piedad Moya's calculations of benefit cost ratios and rates of return for twelve sample systems in Central Luzon in the Philippines are clear at the extreme, showing deepwell pumps to be unattractive, and an interestingly wide variation of performance in communals, with an intermediate level of performance in the one jointly managed system. (P. Moya: 40 - table 16). Donald Taylor and Kanaengnid Tantigate's analysis of costs and performance of different sizes, types and locations of irrigation schemes in Malaysia leads to a tentative suggestion that some caution is justified in encouraging small-scale irrigation and pumping schemes, as well as irrigation in certain regions of the country (1981 a. 14-15). Studies like these

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(1) This is a very arbitrary figure. It assumes that some of the small systems on river schemes should properly be considered as communals. This assumption may or may not be justified. If it is not, the figure becomes 78 per cent.

(2) The 0.11 million ha between 201 ha and 10,000 ha is split equally between jointly managed and communal schemes.

(3) Pump schemes are treated as neither jointly managed nor communal.

provide broad pointers, but cannot and do not confront the question of new potential and costs. As Leslie Small points out (1981: 2-3), it is reasonable to suppose that irrigation projects take the best sites first, and as irrigation is extended, so less favourable sites are taken up and real costs rise. New projects are, thus, probably becoming less and less attractive as investments. One can only conclude in a commonsense way that new projects should be appraised carefully and judged against alternative investments available at the time.

ii. rehabilitation.

One alternative is rehabilitation of existing irrigation systems. Rehabilitation programmes are reported for main systems in Indonesia (Pasandaran:6; Asnawi and Shand passim). Asnawi and Shand conclude their study of the economic impact of irrigation schemes in West Sumatra, Indonesia, with the firm finding that the rehabilitation during 1969-1978 was remarkably profitable and beneficial. In general rehabilitation involves physical construction and reconstruction. It may not be thought necessary to involve significant changes in management. Like new projects, rehabilitation is usually seen primarily in terms of hardware.

iii. management.

Main system management is a third form of investment, discussed at length and in useful detail by Bottrall. The word "management" here refers both to the management of people - irrigation staff and farmers - and to the management of natural resources, notably the distribution of irrigation water. Investment in management can take the form of appraisal, monitoring and evaluation; training staff; improving incentives; reforming procedures; improving communications; liaison between staff and farmers; and the introduction of new methods of distributing water. It is the software of jointly managed irrigation systems.

Construction Bias

It might be supposed that choices between investments in a. new projects, b. rehabilitation, and c. management would be taken on the basis of some serious comparisons of costs and benefits of the different approaches. This is, however, not common. There is a construction bias towards new projects or failing them, towards rehabilitation of infrastructure. For a start, the word "investment" has stronger connotations of hardware and construction than of software - management and training. "Management" tends not to be specifically mentioned, as when P. Moya writes "Investments in irrigation can be for construction of new systems or for rehabilitation of existing ones". Problems of underutilised capacity on jointly managed irrigation tend to be attributed either to poor infrastructure or to deficiencies in the tertiaries. Thus Pasandaran says of the evolution of policy in Indonesia "Following the rehabilitation of the main systems...the need to gain the full benefit of irrigation development was assumed constrained by performance of tertiary systems" (6, 8). Elsewhere, the tendency has been to blame "the farmer" and to prescribe the need "to educate the farmer" in better water management. Whatever substance there may be in these suggestions, they divert attention from the deficiencies and opportunities in managing the main system.

There are powerful reasons why main system management has been a blind spot (Bottrall 1978 a, b; Wade and Chambers 1980). They include the civil engineering training of irrigation engineers, and the many reasons they have for preferring construction to operation[1]; the large sums of money and considerable patronage provided by new projects and major rehabilitation; the pressures within some donor agencies to spend large sums; and the preferences of political leaders and administrators alike for visible, physical achievements: the design and construction of a new irrigation system is an act of creation through which a person can leave behind a permanent mark of achievement. All this is very understandable. But it still requires an effort of imagination to realise just how powerful the combined forces of these biases are working together. Moreover, the construction of irrigation systems can develop an almost unstoppable momentum, as contractors, consultants, ministry officials, the staff of donor agencies, and political leaders all have an interest in a continuous and increasing flow of expenditure and work.

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1. From a survey study of 259 irrigation engineers in Gujarat State in India, Jayaraman and Jayaraman (1981 forthcoming) have found that construction and design were preferred to operation and maintenance because construction and design
   - were more for 'hard' applied science people
   - offered more independence of action
   - were less monotonous and offered more variety of experience
   - carried better promotion prospects
   - involved less public relations
   - were less vulnerable to transfers by dissatisfied politicians

This is not to condemn new projects or the physical aspects of rehabilitation. Both are often eminently desirable. Rehabilitation is also often strongly complementary with improved management. The argument is, rather, that construction bias distracts attention from opportunities in main system management.

Priority for Main System Management

Among the workshop papers, only two are substantially concerned with main system management. Taylor and Tantigate (1981b) examine the economics of water scheduling on the Kemubu Project in Malaysia. But only Anthony Bottrall takes main system management as a central and comparative theme. Of his study of four jointly managed projects in four countries he writes:

> "It was hypothesised that if the expectations about weaknesses in main system water distribution proved correct, many of the water management "problems" below the tertiary outlet, attributed by official agencies solely to deficiencies in farmers' organisation, could be shown to have their origins higher up the system. This would imply that the agencies' conventional diagnosis of water management problems was faulty; that they should adopt a "whole system" approach to the analysis of irrigation management ... and that they should be prepared to reconsider their pattern of investment, which on existing irrigation schemes was concentrated almost exclusively on physical infrastructure at the main system level and on a combination of physical infrastructure and reorganisation at the tertiary level" (1981:5).

That there are weaknesses in main system management and water distribution is very widely documented. Among the workshop papers Tolentio Moya writes of the Philippines that "Notwithstanding the massive scale of recent irrigation developments, the performance of the existing systems is well below the specifications assumed during their construction." He observes an inadequate hydraulic working head at the turnout, and states (1981:14) that "the potential hydraulic working head available at the turnout...is the most important variable that explains water distribution across the farms". In other words, the lower the head, the greater is the inequity of water distribution below the turnout. For his part, Vanpen Surarerks finds water conflicts [illegible] more prevalent in the tail ends of large systems (1981:14) as a result of inadequate and unreliable supplies. Mark Svendsen notes (1981: 22-3) that with a loose rotation in force during periods of water shortage, differences in supplies to head and tail are considerable, and farmers are more concerned with assuring the supply to their turnout than with internal distribution below it. In general, an adequate and predictable water supply delivered from the main system to the turnout is a precondition for equitable and more productive distribution of the water by farmers below.

There is a rapidly accumulating body of evidence that improvements in main system water distribution, achievable either without rehabilitation or with only moderate levels of investment in rehabilitation, can lead to substantial, sometimes dramatic, improvements in both equity and production. The IRRI/NIA work in the Philippines, cited by Bottrall, is well known (Valera and Wickham 1976; Early 1980). Other examples include the tightening and rotation of issues in periods of crisis in Andhra Pradesh (Wade 1980) and Sri Lanka (Shanmugarajah and Atukorale 1976). The introduction of rotations and steady water supplies to turnouts on the Shreeramasagar (Pochampad) Project in Andhra Pradesh is reported to have more than doubled the area receiving irrigation water, and more than trebled the value of production (Ali and Hassan 1980, Hassan 1981). Also in Andhra Pradesh, the introduction of simple rotations (closing channels one day in seven, in sequence) on majors on the Nagarjunasagar Right Bank Canal is reported to have led during kharif 1980 to the irrigation of 3,400 additional hectares for the first time in many years (M. Narayana, personal communication). Again, resolute redistribution of water on a minor on the Kurnool-Cuddapah Canal in Andhra Pradesh in kharif 1980 is reported to have increased the irrigated area, in spite of less water being available, from 361 to 560 acres (CADD 1981). In Indonesia, a pilot experiment in improved main system operation in Cirebon Section, West Java, is reported to have reduced dry season fallow from 40% in 1978 to 10% in 1980 (Bottrall 1981:24).

Now all these figures should be treated with caution: as Jerachone Sriswasdilek and Dhongchart Chullasuk point out (1981: 14), water used in one place can have opportunity costs from not being used in another, and for a full assessment of benefits a net figure is needed. Nevertheless, evidence from the Philippines, Andhra Pradesh, Indonesia and elsewhere has established beyond reasonable doubt the priority of analysing main system management, and seeing, case by case, whether similar large increases in production and improvements in equity can be achieved elsewhere. There may be jointly managed projects where the scope is slight. But in general, the evidence so far suggests that overall the potential from improved management, and especially from changing the manner in which water is distributed on main systems, is enormous. Moreover, the costs are low compared with new projects, and with construction generally.

An Agenda for Analysis, Research and Action

The reasoning and evidence above, together with the papers presented to this workshop, lead towards suggestions for further analysis and empirical research to support and develop improved main system management. The suggestions that follow have a main system bias in line with the terms of reference of this paper. This bias may be no bad thing, if only to offset the current predominance of tertiary level research reflected in the balance of papers to this workshop. But unfortunately no profession or discipline has adopted main system management as its priority concern in irrigation. Sociologists, agronomists and agricultural engineers will surely continue to do useful work below the turnouts. Some may follow the lead of Taylor and Tantigate (1981b) into more detailed examination of the costs and benefits of scheduling. But much more interdisciplinary work is called for to understand the working of main systems, the problems of staff, the distribution of water, and the systems of communication, and to identify feasible paths towards improvement. Contributions are called for from management science, and from many more who, like Bottrall, will take the management of people and of water on main systems as their primary concern.

Seven suggestions can be made:

(i) comparing improved main system management with alternative investments.

Bottrall asserts that the potential benefits from improved main system management are likely to be very high, for example in Indonesia. Others have argued the same for elsewhere. But in the absence of more economic analysis, these assertions may not carry the weight they deserve. There is a plum here waiting to be picked by a good economist.

(ii) reality: how much water goes where, when and with what results

It is at first sight surprising how rarely water is or remains at the centre of interdisciplinary research on canal irrigation. None of the workshop papers reports research which measures water distribution on the main system. It is rare indeed for measurements of water on and below the main system to be linked with other, especially social science, investigations (but see Palanisami 1981 for a notable exception). There is a surprising general ignorance of what happens to water, and how much goes where and with what results. There are problems of myth and reality. Bottrall (1981: 22-3) observes that the pasten system of water distribution in Indonesia is equitable in principle but that it can be very inequitable unless it is exceptionally well directed and supervised. Its complexity makes it difficult to operate, he suggests, and at the same time provides a smokescreen for manipulation. This is by no means an exceptional instance. On one Indian system, the gauge readings for water passed down a canal from one engineer to another are systematically overstated, each engineer reporting that more water is passed on than is the case. There is also sometimes a surprising lack of knowledge about actual flows. One research project in Sri Lanka found, after some months, that the main sluice supplying a system was wrongly calibrated, unknown to the engineers who were operating it. Elsewhere, myths are easily established. In India, where currently steps are being taken to introduce rotational irrigation (warabandi) below outlets (turnouts), there appears to be a danger of an impression that precisely timed rotations between farmers are being practiced in places where they are not.

One dimension is what happens to water at night. It is at night that poaching and irregularities are most common. It may also be at night when inequities are most corrected (as in Svendsen's (1981:19) example of farmers removing upstream checks at night when they are unguarded), or when tailend farmers may find more water flowing to them. It is also possible that much more water is wasted, or badly applied, at night than during the day. Night irrigation, however, remains, if the term can be forgiven, a black box, and to my knowledge no one has ever written about it as a subject in its own right.

The main point, however, is that knowing how much water goes where, when, and with what results, is basic information for any attempt to improve water distribution. Improvements can be, and have been, made without such accurate information, but with it, it should be easier to see where the best chances lie.

(iii) alternatives in water distribution

A central problem is the identification and analysis of alternative ways in which water can be distributed on main systems. Curiously, there is no discipline for which this is yet a major concern. In Taiwan there is an institute set up to analyse, develop and teach methods of water rotation (Robert Wade, personal communication). But elsewhere the subject is still a cinderella. A recent manual on Operation and Maintenance of Irrigation and Drainage Systems published by the American Society of Civil Engineers (ASCE 1980) devotes only some 3 pages to the different methods of water delivery, and its brief discussinn of demand, continuous flow, and rotational methods does little more than tantalise the reader. Nor, in India at least, does academic research appear to have been pointed in this direction: the abstracts of 216 post-graduate theses present in 1970-1975 in hydrology and related subjects at 22 Institutes of Technology, Engineering Colleges, or similar institutions in India, do not include a single direct mention of methods of distributing water on canal irrigation systems (INC for IRP 1977). The subject is mentioned in a leading textbook on irrigation engineering (Singh 1979: 168-169) but the main professional concentration in the section on regulation and control of the canal system is on discharge measurement and the assessment of canal revenue. Methods of water distribution in Asia are just beginning to be written about (e.g. Malhotra forthcoming) but the literature at present is sparse.

To open up this subject, collaboration between engineers, economists, farmers and agricultural economists might help. The sort of questions to which answers are needed are:

- how on system X, do you identify which alternative patterns of distribution to compare?

- how should they be compared? For example, how should it be decided whether to run a channel continuously at one-third capacity, for half the time at twothirds, or for a third of the time at full capacity? How does one determine what rotation intervals are best in what circumstances, with what mixes of what crops?

- what sequences of methods can be adopted as water becomes progressively scarcer during a season?

A further problem is the costs and benefits (broadly defined) of alternative water deliveries to turnouts (outlets). A variety of words are used, no two authors using the same, to describe the characteristics of a desirable supply. Bottrall (1981:8) for example, has adequate, predictable and equitable. A list, in alphabetical order, of adjectives used would include adequate, appropriate, assured, certain, controllable, convenient, dependable, equitable, productive, reliable, predictable, stable, steady, and timely. There is a need here for a tightening of concepts, and a definition of the relative importance of different characteristics in different circumstances.

(iv) <u>the management of staff</u>

We still seem a long way from knowing how to improve the management and performance of irrigation staff. Surarerks (1981:19) mentions "inefficient and dishonest officials". The use of their positions by irrigation staff to secure additional income is widely reported, often alluded to in papers, but rarely seriously discussed in its own right (but see Kandpal 1981 and Nigam 1981 for approaches to this and related questions). Irrigation managers may find themselves sometimes in political and financial traps in which it is difficult for them to do other than conform and comply with requests and give in to pressures. Discussions of improved management perforce take the form of conventional measures - staff incentives and training (Taylor and Tantigate 1981b:20), procedures which make staff visit the fields and measure what is happening (Small 1981:22), accountability of staff to the farmers they serve (Bottrall 1981:25), and monitoring performance and management (ibid.26). All these are worth exploring. Management science has here a contribution to make, with monitoring and performance evaluation concentrated on outputs, as proposed by Seckler (1981). No one solution is likely to apply universally, but three measures should help quite widely:

a. raising the professional interest and status of managing water distribution, and Operation and Maintenance generally. This requires the development of irrigation management more as a profession in its own right, and not as a poor relation in an existing professional family, with individual staff trained in several disciplines[1]

b. increasing farmer involvement in management decisions, to balance political interests

c. providing adequate funds for operation and maintenance, including means of travel and communication.

(v) communication and response

One dimension of main system management is communication and response - the flows of information and the action taken on the basis of that information. Research here could study and compare different methods of communication, their accuracy and speed, and the response time between an event (a breach, an illegal act of poaching, damage to a structure, a local water shortage, and especially rainfall), T. Moya (1981:5) mentions for the LTRIS system in the Philippines a predetermined suspension schedule for adjusting actual water release to rainfall in the service area. Useful lessons might be learnt from this schedule and how it operates in practice, and from those schemes where the response time is short and the responses appropriate.

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(1) As suggested by G.N. Kathpalia (1980:44) for the introduction of warabandi in India.

(vi) farmers above the turnout

It is easy for the naive, ignorant, or superficial observer to slip into the error of believing that the influence and concerns of farmers are entirely oı predominantly limited to what happens below the turnout[1]. But as accumulating evidence shows, this is often far from the case. Bottrall (1981), Duewel (1981), Surarerks (1981) and Svendsen (1981) all describe examples of farmers variously intervening and controlling or attempting to control water movement above their turnouts. Svendsen observes of the PNRIS system in the Philippines that "In the portions of the system studied, the actual changeover in management responsibility occurs at a considerably higher level than it does in the model" (1981:17), and that "informal collective activity is at the heart of water distribution along the sublaterals" (ibid:18). In India, too, farmers have been found to be organising themselves to an unexpected extent in order to exercise control over distribution at levels higher than the outlet (Elumalai 1980; Rao n.d.).

This is an important subject for main system management. In what circumstances, with what effects, can and will farmers manage water above the turnouts? What are the relationships between organisation and management by them above turnouts, and the distribution of water among them below turnouts? Can the experiences with discussion, negotiation and understanding about water decisions affecting several communities (e.g. as reported on a very small-scale by Duewel 1981:22) be repeated and sustained at higher levels? Do or could representatives of sub-laterals, laterals, and even branch canals, discuss and negotiate water allocation and distribution? Is the Taiwanese approach, or that of the D system (Bottrall 1981)) desirable and replicable elsewhere? Is the time ripe for a comparative analysis of this aspect of farmer activity and its articulation with the irrigation bureaucracy?

(vii) appraisal, diagnosis and prescription

The terms appraisal, diagnosis and prescription are used here more or less synonymously with Bottrall's "evaluation" (1981:33). They describe the process of learning about an irrigation system, analysing its problems and opportunities, and identifying measures for improving performance. They are often carried out very quickly, in a few days, by an individual, or by a small team, often an engineer and an agronomist. Bottrall's own technique, taking several weeks, involving the collaboration of a social scientist (himself) with an engineer, and paying attention to management, both of people and of

1. For an example, see Chambers 1981b, where the author, having slipped into this error (p. 5 onwards) is not entirely successful in extricating himself from it (pp. 17-18).

the main system water distribution, is a step forward. The question remains: what mix of what sorts of people, doing what, how, over what period of time, can be considered optimal for this task?

Answers will vary by system. A case can be made out (Chambers 1981) for a fairly rapid and flexible appraisal, by a mixture of engineers, and natural and social scientists, using recently developed and systematised techniques of rapid appraisal(1) (Collinson forthcoming, Hildebrand forthcoming). The questions to be asked by such teams would include not just conventional disciplinary concerns, but also cross-disciplinary questions concerning implementability: one key question, touched on by Bottrall (1981:), is who would gain and who lose from changes, for if water redistribution can enable all farmers to gain, then it will be much easier to introduce than if some must lose. The major point here is the need to learn from experience already gained with approaches to appraisal, diagnosis and prescription, and to learn more again through trials with new approaches. Such appraisals should themselves be a subject for research - for experiment, description, analysis and comparison. For if a cost-effective approach could be developed and replicated, the benefits should be high indeed.

(viii) action research

Some of the suggestions above sound like subjects for conventional research. But the urgency, the opportunity, and the complexity of irrigation are such that this will often not be the most cost-effective approach. Action research is often better than conventional research, and involves deliberate intervention into irrigation systems, and the testing, monitoring and adapting of changes. In developing main system action research, the Philippines have had a pioneering role and successes which augur well for the future. Action research on irrigation main systems is now receiving serious attention as a subject (Bottrall 1981, Lenton 1980), and is spreading rapidly in India and perhaps elsewhere. More needs to be written and shared about the difficulties it faces and the methods used to overcome them.

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(1) For appraisals of smaller, communal systems, and for methods and advice with much wider applications, see de los Reyes n.d.

Concluding

This leads to the final question, which is perhaps the deepest question facing social scientists and others concerned with irrigation research, whether main system, below the turnouts, or on communals. It is how to identify choices in research and action research, and then how to make the best choices. It is not difficult to list "priorities" as I have done. But which are best? Which, for example, would most benefit the poorer of those who depend, or who might depend, on irrigation for their livelihoods? I will conclude by hazarding three judgements about good choices of research and action research:

i. good choices will be based on assessments of the nature and orders of magnitude of a. potential benefits, b. beneficiaries, and c. replicability

ii. good choices will rarely, if ever, involve the sort of single discipline research taught in much current professional training

iii. in the short term, good choices may not be recognised by narrow conventional peer groups, but in the medium term, because of the clear contribution they make to development, they will be widely recognised.

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