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Viewpoint – Responding to Context: Some Lessons from Experience in the Water Sector

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ABSTRACT: This paper focuses on an important lesson arising from long experience in Asia: the importance of adapting interventions in the water sector to their context. Water is pervasive and failure to appreciate how water programmes fit within a broader economic, environmental and social context can incur large costs. Too often we outsiders, not to mention local politicians and bureaucrats, have been driven by our own thinking and interests, imposing approaches and solutions that may be appropriate in wealthier and more manageable situations but which fail to take into account the complexities of the vast regions of Asia and their huge populations, widespread poverty and traditional practices.

The argument is illustrated in two ways. *First* by a brief review of programmes in five widely differing river basins: the Aral Sea Basin in Central Asia; the Mahaweli Basin in Sri Lanka; the Ponniar Basin in South India; hydro-power development in Nepal and Bhutan; and the massive 3-H (Hai-Huang-Huai) basins of the North China Plain. This review illustrates how basin interventions can have profound implications for the development of whole regions, even countries, and that politicians and water professionals have too readily driven priorities that are insensitive to the real interests of the areas concerned, whether they involve action (as in the Aral Sea, Mahaweli and Ponniar cases) or inaction (as in Nepal). A measured approach (as in Bhutan and North China) within a broad understanding of the interests of the country or region concerned can have major benefits.

Second, by an assessment of the irrigation sector. Irrigation is by far the largest water user and has played a central role in Asia's agricultural development, yet there has been surprisingly little progress in understanding how the prevailing context and associated incentives impact on farmer and official behaviour. This has, in my view, resulted in misjudgments concerning irrigation potential and returns. The issues are discussed under four headings: water use, crop output, institutional performance and irrigation modernisation. They may need modification in a warming world, but as they stand the paper's conclusions suggest that within its context Asian irrigation is more productive – and, dare I say it, efficient – than is commonly supposed. Failure to recognise this fact has led to unrealistic expectations from irrigation interventions and hence to wasted resources and effort.

KEYWORDS: Water, experience, context, river basins, irrigation

One important lesson is to expect the unexpected. For most of my career climate change was unforeseen, yet in retrospect much would have changed if climate risks had been recognised earlier. Also unforeseen was the emergence of a financial system that – besides its role in legal activities – facilitates corruption, tax evasion, money laundering, trade in drugs and arms, and other ills on a massive scale. How far these factors negate the justification for past aid projects on which I spent my career is an unsettling question. Even if the global context falls beyond the remit of the water professional, the local context does not. A second lesson is that we have paid too little attention to the

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local context, driven by our own thinking and interests, with cost-benefit analyses, mathematical modelling and technical sophistication too readily providing a cover for promoting preconceived ideas.

This paper illustrates some of the issues that can arise when the local context is misread. It is in two parts. The first reviews a varied set of river basin examples. The second addresses the irrigation sector: it argues that a common failure to appreciate how farmers and officials respond to incentives can lead to a miscalculation of irrigation returns.

SOME RIVER BASIN EXAMPLES

River basin management is inherently a public-sector responsibility. This reflects the well-known characteristics of water that set it apart and limit the role of markets – its pervasive character, the risks associated with stochastic supply, the externalities to which water use gives rise, etc. The river basin examples discussed in this section are selected with a view to throwing light on a range of strategic consequences that can arise when decision-makers (national and donor) misjudge – or otherwise – the broader political and/or economic context.

The Aral Sea. The Aral Sea programme sponsored by the World Bank in the 1990s is an example where inadequate weight was given to local views and experience, in part because their validity was undermined by an association with the failed Soviet system. Following the break-up of the USSR, the five 'Stans' suffered an economic crisis more severe than that of the thirties, let alone that of today. It was thus to their great credit that an Aral Sea agreement was signed so expeditiously. This agreement secured prior water allocation and distribution practices until such time as they were renegotiated; maintained the basin agencies for the two great rivers, as well as the central research and design entity; specified financial, staffing and other pledges by each country; and created a Ministerial Committee to give policy direction. Uzbekistan and Kazakhstan drove the agreement since they had most to gain if upstream dams were operated for summer irrigation rather than for winter power. But this is not the point. The agreement represented a pragmatic basis for cooperation in terrible times and if it had not existed, we would have almost certainly proposed something very similar.

It might be expected therefore that the donors would have responded positively to the initial request for equipment, technical assistance, studies, etc to help sustain this interim framework as they became gradually familiar with a region entirely new to them. Not a bit of it. It was assumed that these 'new' countries were essentially starting from scratch and in need of guidance. The agreement was accepted with little comment while basin management practices were criticised with little recognition given to the impact of the economic crisis. Outsiders piled in with hastily conceived proposals, many based on analogies with basins of limited relevance in Central Asia. For instance, the Bank presented a seminar on Indus and Mekong experience, neither of which had much relevance for the Aral Sea. All three treaties of course had an important planning dimension, but the Indus treaty was in the nature of a territorial division that required minimal cooperation in subsequent basin operations and the only structures on the Mekong between the Chinese border and the sea were then some bridges! In contrast, basin operations are *the* key issue in Central Asia. There is a vast complex infrastructure comprising dams, diversions, pumps and other structures, on rivers that start in one country and flow into others, and sometimes back into the first country. Operation of this infrastructure has to be coordinated if there is not to be chaos as individual countries adopt beggar-my-neighbour practices. However, rather than strengthening the interim arrangements, a complex ill- thought-out programme was developed by the Bank and hastily adopted, which included ambitious new institutional components. This programme failed to recognise that the Soviets had already addressed many of the most important issues, in my view fairly well. Moreover, driven by environmental concerns that dominated the headlines, an unprofitable debate was started on 'saving the Sea'.

The 'Stans' in their turn failed to understand how aid agencies operated, implicitly assuming that they would replace Moscow's funding role. There were also weaknesses in their policies, which were

further handicapped by inter-country disputes. But again this is not the point. It was up to us to understand the context in which we were intervening. The main misjudgement was our failure to recognise the central importance of the basin agencies. Rather than supporting these, the Bank was party to setting up an Aral Sea Fund into which the countries were to deposit 5% of GDP (!), in theory supplemented by the Bank and other donors. There was no way that this Fund would amount to anything. The Bank and other donors had no intention of dumping money in a consolidated fund, and comparison with the fund that financed projects in Pakistan under the Indus Treaty was misleading. And the idea that finance ministries facing an existential economic crisis would divvy up 5% of GDP was preposterous. The Bank also promoted other institutions, *inter alia* to supervise the water agencies and manage the environment, requiring senior ministers and officials to oversee and/or bypass the water ministers and technical staff participating in the Ministerial Committee. The main environmental body migrated like a lost soul, barely staffed, ending up in Ashkhabad and, though I am not informed of the details, my understanding is that within ten years the institutional structure had relapsed to something very much like its original form – perhaps with additional environmental components. It is dispiriting to think what could have been achieved if the focus had been on the basin agencies from the start.

The programme supported by the Bank encountered delays, difficulties and disappointments. Perhaps there were successful items in what was a large and complex programme but in most ways it was a tale of confusion, missed opportunities and wasted time and effort. In this regard, I have to confess to misjudging the planning component. By the time this came to the fore, I was a consultant engaged by the Central Asians mainly, but not exclusively, to address the component dealing with basin planning. I based my proposals on what local staff had written but what emerged was much too ambitious and over-complex. I tried too hard to be comprehensive and the consultants subsequently engaged in carrying out the study struggled with the TOR I had largely drafted. I regret this outcome very much.

It took perhaps a decade for the distortions arising from this mutual misunderstanding to work their way through, distortions that in my view could have been largely avoided if a cautious and informed approach had been adopted. Of course much happened: money was spent, projects and studies were completed. That is the nature of the aid juggernaut. But so much more could have been achieved if we had worked closely with the basin agencies from the start. As for the Aral Sea, its fate was sealed by the initial Soviet decision to divert water away from the main rivers and confirmed by the later cancellation of the Siberian water diversion project (though I doubt this would have done much to save the Aral Sea). There were it is true some notable achievements (e.g. in the Syr Darya estuary) but much aggravation could have been avoided if we had accepted from the start that the main Sea was doomed.

The Accelerated Mahaweli Development Programme (AMDP). The AMDP in Sri Lanka was a phenomenon. In many ways it represented a late expression of the Tennessee Valley approach to river basin development, an approach that greatly influenced thinking before the environmental movement came to prominence. It was launched by the Jayawardene Government when it came to power in 1977. Provided its political objectives were achieved, the Government of Sri Lanka (GoSL) was largely unconcerned if foreigners took the lead which they did with gusto. There is a famous saying by King Parakramabahu from the 12th century that "not even a drop of water must flow into the ocean without being useful to man", and Mahaweli provided President Jayawardene with a stage on which to recreate the glories of the ancient Sinhala kings. Furthermore, irrigation was politically popular with the Sinhala and had the added advantage that land came under Sinhala settlements that would otherwise have fallen to spontaneous Tamil in-migration. This had been a long-standing aim of dry zone development, and the pro-Sinhala bias was further indicated by the illogical exclusion of the remarkable Giant's Tank in Moslem Mannar district, which clearly fell within the greater Mahaweli catchment area and could have benefited e.g. from planned releases from the reservoirs.

For a number of years the GoSL and the Bank prepared a joint paper for the aid group that scheduled future Mahaweli costs and timings. Based on this – to be frank – unrealistic paper, donors

competed with abandon to fund the dams, irrigation systems, power stations and other projects that comprised this – in relative terms – massive programme. At its peak, the ADMP accounted for more than 40% of public investment expenditures and contributed to financial and inflationary pressures that unbalanced the whole economy. And for what? At a cost that was perhaps five times that for new irrigation in India, it settled rice farmers on one-hectare subsistence plots with permeable forest soils mostly unsuited to paddy and with few prospects for future income growth. 'Creative' cost-benefit analysis struggled to show a positive return and acceptable farm incomes, illustrating the self-deception that is so common in irrigation appraisal. Not only can benefits be readily manipulated (e.g. by adjusting assumptions on water use efficiency, crop yields, areas under high-value crops, etc) but costs and implementation periods are typically underestimated. In the particular case of Mahaweli, the costs of major dams were in fact entirely omitted on the grounds that they were 'covered by power' even though Bank power appraisals correctly attributed 60% of these costs to irrigation. Though Mahaweli added significantly to power generation capacity, its contribution to rice output was far less than that attributable to the (essentially cost-free) market reforms implemented simultaneously by the same government.

As in the case of Central Asia, the shift from a socialist to a 'free market' government was why Western donors became involved in the first place. But the AMDP was inconsistent with the economic stability essential for a successful private sector, and was by most standards an unfortunate strategic mistake. Goh Keng Swee, the then Minister of Finance of Singapore, invited by the GoSL to review its industrialisation programme supposedly modelled on Singapore, concluded that priority should have been given to tea and rubber and not to irrigation and industry. Instead, the plantation companies (by far the largest private concerns then operating in the country) were given 5 years' warning that they would be taken over. When this occurred, their owners had predictably run their assets into the ground, dissipating long-standing technical and managerial skills in the process. As Goh argued, Sri Lanka should have modelled itself not on Singapore but on Malaysia.

As it was, the GoSL was mesmerised by the irrigation works of the ancient Sinhala Kings, a good illustration of how symbolic capital can so readily be transformed into political capital by a grand project. The donors did Sri Lanka no service by failing to evaluate AMDP adequately within its macroeconomic context and by accepting this programme with so little criticism, indeed with much enthusiasm. Why this was so, I never quite worked out, though the dichotomy in the Bank between the views of economic staff, who pointed out the macro stresses to which the ADMP gave rise, and the gung-ho attitude of project staff (supported by senior Management) looking for lending opportunities, undoubtedly played a part. The other donors no doubt had their own political agendas but were able to take their cue from the joint GoSL/Bank paper.

Bhutan and Nepal. If Mahaweli was a late expression of the Tennessee Valley ethos, Nepal was an early casualty of the emerging hostility to dams.

I have never worked in Nepal but on visits to Bhutan I was impressed by how this small Himalayan kingdom allowed India with little if any fuss to exploit its hydropower potential – as in Nepal easily its most important economic resource – on essentially an enclave basis. No doubt India, in constructing the first run-of-the-river project (Chukka) in the 1980s took advantage of a weak government but with each new such project the terms shifted in Bhutan's favour ensuring that royalties have progressively increased. This has given Bhutan a financial independence that, freed from donor pressures, has enabled it to implement a successful socio-economic programme that reflects its own character and priorities.

Indian assistance to Nepal in the 1960s/70s for run-of-the river projects was primarily a by-product of massive irrigation projects in India itself. In part due to experience with these, Nepali suspicions of its giant neighbour meant it turned to donors to assist it in the preparation of feasibility studies for the massive storage dams that were thought to be the next step. This involved Nepal, India and the donors

in complex negotiations that contrasted markedly with the straightforward approach in Bhutan. Moreover, when donors urged on by NGOs in due course took against storage dams, the storage projects came to nothing. As in Bhutan, consideration then shifted to smaller run-of-the-river projects but donors continued to be involved and, in due course, turned against even these. One of the first acts of James Wolfensohn on becoming President of the World Bank was to withdraw funding from the notorious Arun project despite this project being sited to minimise environmental harm at the cost of reducing potential power returns; and despite detailed consultancy studies on a scale that dwarfed anything India had undertaken in Bhutan.

To this day, despite its vast hydropower resources, Nepal is unbelievably a small net *importer* of electricity from India, and the World Bank has – again almost unbelievably – approved a project in support of facilitating such imports. In contrast, Bhutan – with a GDP no more than a tenth of that of Nepal – has recently signed an agreement to supply India with an annual amount equivalent to 50% more than the *total* electricity consumed in Nepal. Whereas Nepal continues to face appalling economic problems, along with political problems, in part a product of its economic difficulties, electricity exports have underpinned Bhutan's economic success and given it an independence from donor pressures that Nepal must envy.

The Ponniar Basin. The Ponniar is a small basin in South India that illustrates what can happen when there is a failure to constrain basin development, in this case by the Tamil Nadu authorities rather than by the donors. Historically, irrigation began with the construction of small village tanks distributed widely throughout the catchment area. Variable stream flows and the high cost of well construction in hard-rock areas limited exploitation of other sources, though wells were built for water supply and some flood flows were diverted into the tanks, notably in the delta. The first major interventions in the basin regularised and added to these diversions via a series of three anicuts (weirs) constructed across the main river. These weirs led to a large increase in productive irrigation, both directly and via the system tanks. Such delta projects had been pioneered by the Chola kings, notably when they constructed the famous Grand Anicut across the Cauvery almost 2000 years ago, and over the centuries have proven a highly successful and low-cost means of supplying South India with its rice needs.

The next major development in the Ponniar Basin was upstream of the delta with the construction in 1958 of the Sathanur and Krishnagiri dams on the main stem of the river to store wet season flows and regulate supplies in the lower basin. To exploit the potential of these dams, new irrigated areas were built and regulations were prepared that, in principle, safeguarded the interests of delta farmers. Inevitably, however, farmers who had failed to benefit from the first phase began to place pressure on their local representatives to extend irrigation to their fields. This led to the progressive expansion of the existing schemes and then to further small dams and irrigation projects in the upper reaches of the basin. Demands for urban water supply and industry also steadily increased. As a result, flows in the lower river progressively dried up and sometime in the 1970s the lowest anicut, which incidentally diverts water to Pondicherry, received its last ever supplies, leading in due course, to the farmers who had previously received supplies petitioning that their irrigated land be deregistered for land tax purposes. Much of the river is dry for much of the year and conflicts between the upper delta and Sathanur, between the left and right banks, and between Sathanur and upstream dams and users, have all accumulated.

It is as well to review what actually happened. Productive delta lands were increasingly deprived of water as development moved upstream into smaller tributary catchments with ever poorer soils and ever more uncertain supplies. Farmers responded to increasing water scarcity by investing in expensive wells, and donors promoted system modernisation, tank rehabilitation and town water supply projects, all of which have further reduced flows in the river. A combination of farmer pressure in upland areas (believing they had previously been hard done by), the search for votes and influence by politicians representing these farmers, and the construction bias of the irrigation department and donors, have trounced all resistance by delta and other established farmers. It can be argued that over time the

failure to constrain basin development has at considerable cost *reduced* agricultural output and progressively ruined the delta and other environments in what is now a basin that is fully 'closed'. Though the Ponniar is an extreme example, the failure to constrain water resources development to that which is justified by the resource is a common problem, and not just in India.

North China. Water scarcity on a scale vastly greater than in the Ponniar Basin is illustrated by the Hai-Huang-Huai (3-H) basins of North China. In contrast to the failure to control irrigation development in the Ponniar, the 3-H basins provide a case where rapid general economic development has encountered acute water constraints, so much so that a massive new water supply project is being implemented with a view to moderating pressures on the water resource and on the environment.

The 3-H basins account for more than 7% of the world's *total* population. Renewable water per head is less than 500 m^3/y (350 m^3/y in the Hai Basin) and water constraints are as severe as in any other populated region worldwide. An enormous water infrastructure has been constructed, rivers have dried up, water tables have fallen, and the environment has become severely degraded. Large investments – some supported by donors – have been made to increase the efficiency of irrigation water use, though how far this has in practice released water for productive use elsewhere may be questioned given that these basins are essentially closed. Faced by this deteriorating situation, and to help address the associated problems, the Government of China is constructing elements of the controversial South-North Water Transfer project that will bring substantial water to the North China Plain from the Yangtse Basin. The question is: is this project justified?

Generalised water scarcity wherever it occurs is reflected primarily in environmental stress and in declining areas under low-value agriculture, since cities and industries usually secure their supplies (even if this is costly and – at the limit – from desalination); and richer farmers can usually out-compete low-return agriculture by coercing suppliers, deepening wells, buying in water, etc. On the 3-H plain this seems to be confirmed by the continued rise in agricultural value-added despite the acute and rising scarcity of water. This scarcity has, however, contributed to the abandonment of agricultural land and, along with the conversion of land to urban uses, has intensified rural-urban migration. The expansion of massive cities, including Beijing and Tianjin, has been associated with unprecedented growth in GDP and severe environmental deterioration. Nevertheless, assuming GDP continues to grow rapidly, urbanisation seems likely to be sustained and the present generalised pattern of growth can be expected to continue. Water scarcity can hence be expected to intensify.

It follows that, at the margin, the South-North Diversion Project will preserve low-value agriculture and – if water can be devoted to this purpose – contribute to a somewhat healthier environment. These benefits must be set against the enormous costs of the project, the large population displaced by the works, the impact on the exporting (Yangtse) basin, and other disadvantages. These factors have led many outsiders to question justification of the project. These observers typically support their case by asserting that water scarcity can be effectively addressed if water is used more efficiently. This is unconvincing given that essentially no water reaches the sea other than sewage and uncontrollable flood flows, so that basin efficiency approaches 100%. Strangely they also often argue against the project on environmental grounds, yet it is hard to imagine any improvement in the environment of the region without some additional water. Other observers, including the Government of China and the World Bank, have come to diametrically opposite conclusions employing ambitious hydrological and economic modelling techniques which purport to demonstrate that the benefits justify the costs. Unfortunately, these studies are also unconvincing given the enormous complexity of the situation, the innumerable simplistic assumptions that have to be made, and the great uncertainties surrounding the analysis.

If cost-benefit analysis is an unreliable guide, on what basis can a decision be taken? Perhaps the most promising approach is to consider the project in its broader political and economic context, while being cautious in implementation. Planning of the project has taken decades and by staging it in three

main components, and confining the initial phase to the very different east and central alignments, important lessons should be learnt. Though very costly, even if fully implemented, the project will add no more than about 15% to the region's renewable supply. Moreover, for a population of more than 300 million costs per head will be small and most estimates of the cost per cubic metre fall below its marginal value. There is furthermore little danger that water will go to waste since losses will be reused directly or go to recharge groundwater. More generally, by slowing retrenchment in farming, the project will moderate rural-urban migration (even if at the margin); diminish social stress; restrain conflicts between users; and utilise existing infrastructure more effectively. Perhaps more significantly, the new supplies will be under the direct control of the authorities and can be readily allocated to priority cities and other purposes at the lowest feasible cost and without serious resistance from prior users. Finally, it is possible that some water can be directed to serve environmental ends.

This discussion can only touch upon a few of the issues involved. Even so it suggests that a regional development approach to evaluation would provide a more convincing case than cost-benefit analyses. On balance, such an approach seems likely to support the project and, at the very least, provide a reasonable rationale for the decision to proceed by the Government of China.

Conclusions. The basins discussed in this note vary greatly and raise very different issues. All, however, demonstrate that basin investments can have profound implications for the economic development of whole regions, even countries, and that river basin planning and management must respond critically to this wider context. Politicians and water professionals have too readily driven priorities that are insensitive to the real economic interests of the countries concerned, whether it involves action (as in the Aral Sea, Mahaweli and Ponniar cases) or inaction (as in the case of Nepal). The costs of strategic decisions that go astray can be huge; and programmes launched in haste are exceedingly difficult to redirect if this proves necessary. A measured approach (as in Bhutan and North China) within a clear understanding of the overall economic interests of the country or region can have major benefits.

ASIAN IRRIGATION

Basin planning is by its nature varied and location-specific. Individual sectors on the other hand share commonalities, an understanding of which helps inform basin analysis. Irrigation is a good example. This is not to understate the need to plan and operate irrigation schemes in ways that are responsive to local conditions. But irrigation performance reflects a range of incentives that, even if their influence varies from place to place, share a number of important features. Given that irrigation is by far the largest water consumer, there has been surprisingly little progress in understanding how these incentives impact on farmer and official behaviour. This has, in my view, resulted in significant misjudgements on irrigation potential and returns.

Recently I attended a talk by a World Bank official on Indian irrigation that could have been made at any time over the past 50 years, not only in terms of its diagnosis of 'present' problems (average water use efficiency no more than 30-40%, crop yields far below their potential, corrupt irrigation departments that are incompetent and overstaffed, farmers who fail to cooperate with each other, technically outdated systems, etc) but also in terms of its prescriptions (irrigation modernisation, water user associations, volumetric pricing, institutional reforms and training, agricultural research, etc). The presentation was indicative of the rut into which too many analysts have fallen. Successive cohorts of advisers rediscover the same evils; blame their predecessors for failing to understand what is needed; and prescribe solutions that appear sufficiently novel that they are persuaded that this time will be different. Few sit back and ask the obvious questions. Why are things the way they are? Why have past interventions so often failed to achieve their objectives? If performance is as bad as is suggested, why are the underlying causes so difficult to address? And if not, how far were the interventions misconceived from the start?

Part of the problem is that irrigation appears such an obviously 'good thing'. This easily slips into the conclusion that public interventions are necessary if improvements are to be achieved and irrigated areas are to expand. Further support for investment results from competition between upstream and downstream users and between different types of users; and from the self-interest of bureaucracies and donors looking for work and projects. Moreover, at least in the case of India, and at least since the 1972 Irrigation Commission, irrigation planners have set targets largely in terms of irrigation potential. In other words, plans are based on the assumption that all accessible water should be exploited. Lip service is paid to cost-benefit analysis, but self-deception is absurdly easy in irrigation appraisal: a limited reduction in average water use per hectare or a modest increase in yields or a 'reasonable' switch to higher return crops are all that is needed to justify a project; and who can say if these objectives are unattainable?

But is Asian irrigation so inefficient? Inefficiency is of course in the eye of the beholder and Asian schemes undoubtedly fall short of what might be achieved in a different context – a developed economy, large enterprising farmers, well-paid operators, advanced technologies, a sophisticated marketing and financial system, guaranteed prices, etc. But this is not the point. Though surface schemes in Asia often look a mess, in my view they can be surprisingly productive relative to what it is reasonable to expect given the enormous size of many of these projects and the number of small farmers involved. This can work both ways. If efficiency, however defined, proves higher than expected, then the benefits from new irrigation may be greater than anticipated ex ante. On the other hand, costs are frequently understated and in my experience potential benefits are often exaggerated, sometimes very substantially. The issues are complex and conclusions based on past experience may need modification in a warming world, but for what they are worth, they are discussed under four headings: water use, crop output, institutional performance and irrigation modernisation.

Water Use. Why is average water efficiency apparently so low in Asian surface schemes? Is this a problem? And if so, why have efforts to raise average efficiency failed so dismally? The answers may lie in an understanding of how water availability affects farmer behaviour.

Each farmer responds to rainfall – from day-to-day, season-to-season, year-to-year – and average water use represents the outcome of the actions of vast numbers of small farmers acting in their own interests under conditions that are highly variable over time and by location. And what are these interests? The realities were once explained to me with clarity by an Andhra Pradesh farmer. Much of the time, he said, there is more than enough surface water to go round – after rain often too much – and it is pointless saving it. If water stress occurs, but there is a broad sufficiency, then he and his neighbours cooperate – after all they are his friends and he has to live with them. But if there is not enough water to go round, then it is each for him or herself no matter what has been agreed, because what is more important than securing food for your family? The actions of a farmer are thus determined in the context of his immediate surroundings. No scheme manager can service the needs of such a large number of farmers in anything like such a detailed manner: all that can reasonably be achieved is to place constraints on the water provided and let the farmers get on with it. Such constraints can be more readily imposed under conditions of low rainfall, which helps explain why the *warabandi* system (allocation by time) has proven resilient on the alluvial plains of North West India and Pakistan whereas attempts to extend it elsewhere on the subcontinent have failed in the face of higher rainfall, variable topography and/or impermeable soils.

Another way of putting it is that a farmer makes full use of surface water when water is scarce (when it is of value to him); but allows it to 'go to waste' when it is abundant (when it is of little or no value to him). In desert areas and during the dry season, when water is scarce for most of the time, the farmer remains continuously alert to the value of water, and average efficiency tends to be relatively high. Average efficiency is lower in higher rainfall areas but significant waste only occurs when water flows to the sea or storage opportunities are lost. When surface water is scarce every last drop is used; and when it is in surplus it either recharges the groundwater or runs off downstream. As groundwater,

it adds to a resource that the farmer can control: this is at a cost and again he/she only uses it if its value is more than his/her costs. As run-off, it is exploited downstream by farmers also acting in their self-interest. At the limit, in a closing basin, no water runs to the sea and average water use approaches 100%. The contrast between shortage and abundance leads to system deterioration as farmers fight to secure water when it is scarce and damage the infrastructure to relieve flooding when it is abundant. The result may look a mess but if *all* the water is used when it has value, then by most standards water is used efficiently.

Water scarcity thus creates incentives for efficient use that can hardly be bettered under the conditions facing most farmers in Asia. In effect, the response of farmers to physical scarcity achieves the outcome set for volumetric pricing *without* the need for detailed measurement and charging systems. Even if the formidable practical problems of water measurement and charging could be addressed, which is doubtful, volumetric pricing is unnecessary. Cost recovery remains an important issue but there are pragmatic ways of addressing this objective – flat rate charges on cropped areas or land, or via the tax system – that do not need the detailed interventions implied by volumetric pricing. And though there are limits to the physical deterioration of the system that can be permitted, the high standards of maintenance so often advocated in many cases may be unnecessary.

Scarcity in surface water systems promotes efficient use but it is above all the spread of groundwater within – and beyond – the perimeters of surface schemes that has been the most important development of the past 50 years. In India, for instance, more than 50% of irrigation is now based on groundwater. Since pumping is under the control of the farmer, he can respond in detail to the rainfall and surface supplies (if any) that he receives, not only in terms of the volume pumped but also its timing. In other words, he only pumps when – from his perspective – marginal returns exceed marginal costs, so applications can be optimised in the light of his own particular circumstances. This happens over vast areas inhabited by innumerable small farmers and dwarfs any benefits that in principal might arise from investments in modern surface control systems. These simply cannot optimise supplies to every farmer or even any group of farmers, and have generally proved a waste of effort and money. Surface supplies may still (greatly) exceed groundwater use and are often critical to groundwater recharge, but they are best scheduled in a predictable manner to the level that can be controlled (the 'structured' level), leaving farmers to optimise distribution and water use below this level.

Of course, groundwater use may still fail to optimise output in an economic sense – it may be subsidised in which case low marginal costs lead to over-pumping; pump owners may exploit monopoly powers in which case weaker farmers may pay too high a price; and aquifers may be over-exploited over the longer-term. These factors impose constraints on the farmers concerned and have led many observers to worry about the sustainability of groundwater as a resource. Some aquifers will no doubt be exhausted but this does not happen all at once and as conditions evolve, farmers adjust by deepening wells, changing cropping patterns, abandoning irrigation etc. It is unfortunate that some lose out, but the adjustments tend to be gradual and at the margin in the context of evolving agricultural conditions where other changes – as in Northern China – can be far more significant. Climate change could shift the balance of the argument in unforeseeable ways, but exhaustion of groundwater in some areas needs to be placed in the context of others where it is regularly replenished and/or surface water supplies are adequate for most of the time. And while such inequities are disturbing, they are typically much less pronounced than those between large farmers and small farmers, or between rainfed and irrigated farmers, or between rural and urban dwellers. If inequities are to be truly addressed, then this needs to be through regulatory and/or planning interventions in a much broader context.

Crop output. Yield comparisons are often said to be of major concern, when yields are low relative to research results and/or to those obtained in comparator countries. But why do crop yields remain lower than theoretically possible year after year? And why do relative yields between countries/regions

and between farmers in different locations often remain broadly similar over time? Environmental conditions and research deficiencies in themselves provide insufficient explanation.

High-value crops are seldom the major issue. Outputs of these crops (vegetables, commercial crops, etc) are determined primarily by market demand – local and foreign. Richer and more enterprising famers invest in groundwater and pre-empt surface supplies so as to satisfy this demand subject to the prices and risks that they face and the technologies that are available.

In contrast, low-value/high-weight grains (and to some extent oil seeds) are the default crops for the large majority of farmers. And here the argument can be expressed in almost mathematical terms. If, for instance, average grain yields in India were as high as in China, there would be massive overproduction since the cultivated area in India is so much larger relative to its population than in China. No small farmer leaves his land uncultivated if he can help it, especially if it is irrigated, so the balance at national level has to be maintained by adjustments to average yields, with yields in each location determined in some sense by the incentives and risks that farmers face, the extent and nature of government interventions, and no doubt other factors. At the limit, if necessary to maintain the balance, some farmers revert to subsistence. Large local surpluses would be reflected in a collapse in local prices as markets adjust to export-equivalent prices for what are typically low-value/high-weight (and hence high transport cost) goods. Or else they would result in unacceptable food support costs in the case that the government subsidises exports. Neither of these results is sustainable. In practice, both India and China have maintained broad self-sufficiency in food grains as population and incomes have risen, so that yields must have adjusted to those that correspond in some sense to self-sufficiency.

Many countries fall into the category of broad self-sufficiency. There are of course countries with a structural deficit (such as Egypt), which can obtain high yields in response to (high) import-equivalent prices or government subsidies or trade controls that shift the burden to the consumer; and countries with a natural comparative advantage (such as Thailand), which find it profitable to export grains even at (low) export-equivalent prices. On the whole, however, trade in grains accounts for a relatively small part of total output (5-6% of the global rice production, 14-15% for other grains) even if trade volumes are large in absolute terms – after all grains account for 60% of world cropped area and more than 50% of calorific consumption. Numerous factors affect output but *as a whole* yields must adjust to a national incentive framework that is in some sense related to the quality and extent of its land resource. Since the land resource remains relatively constant over time, this helps explain why relative yields in different countries also remain fairly constant over time.

This suggests that crop yields are less amenable to being increased by irrigation and other interventions than is commonly supposed. No doubt pilot programmes can produce high yields, but yields elsewhere in the same country must necessarily adjust to restore the balance. In some contexts, research can relieve a general constraint on yields if it leads to falling prices and rising average consumption (the impact of the green revolution fell into this category). But if consumption is limited primarily by incomes, then it is better to think of research as expanding the range of options open to the farmer rather than as relieving a general yield constraint. It is the farmer who decides what technology to adopt in light of the incentives and risks that he faces, and failure to adopt high-yielding practices is seldom predominantly a function of ignorance. That average grain yields in India continue year-after-year to fall short of those in China reflects the decisions of innumerable informed farmers responding to their own interests rather than to any lack of farming skills relative to their Chinese counterparts.

Institutional performance. Irrigation departments are repeatedly criticised for their numerous deficiencies; and training and pilot activities are repeatedly implemented to address these issues. Social engineering in the form of water user associations and similar initiatives are promoted not only in their own right but also to complement efforts to improve public performance. Why then have these initiatives so often been disappointing?

The most direct answer is that expectations have been overstated. Interventions can obviously have some effect, but it is unreasonable to expect ill-paid staff lucky enough to have a job in a poor country to act in ways typical of well-paid staff in rich countries. It is equally unreasonable to assume practices and competences in the irrigation sector that differ appreciably from those prevailing elsewhere in the country concerned. On the contrary, irrigation staff can probably be expected in some sense to perform at levels below the average. Irrigation is simply not at the forefront of economic development and cannot compete for expertise with the engines of growth in the broader economy, not only in private enterprise but also in better-resourced public agencies such as in the power sector. Irrigation departments have become employment repositories; wages and salaries have declined accordingly; and performance has deteriorated. This is likely to persist until general levels of performance throughout the public sector significantly improve.

Uttar Pradesh provides an extreme example. At one time the Chief Engineer was what it says on the tin: he was the highly paid boss of an important, respected and lean organisation. But in due course employment pressures and the interests of the staff concerned led to the appointment of additional chief engineers, which in due course created the need for an Engineer-in-Chief, which in turn led to the appointment of additional Engineers-in-Chief. Last I heard there was a Chief-Engineer-in-Chief, in charge of four Engineers-in-Chief, in charge of a large number of Chief Engineers. This is of course ridiculous but it is hard to believe that grade creep and overstaffing could have been avoided. Indeed it occurs at every level. This does not mean that all staff are incompetent. Everywhere I went during my career I met well-intentioned and competent hard-working irrigation staff performing to the limit of their abilities under extremely difficult conditions. However, the incentives they get and the opportunities they can exploit are invariably constrained by the bloated and dysfunctional organisations in which they serve.

Overstated expectations have also typified advocacy of water user associations and similar forms of social engineering. Efforts to promote famer involvement in water distribution and management have no doubt had some effect but I have long had reservations concerning the form that these efforts have taken. Farmers think about and discuss farming *all* the time and do not need outsiders – many of whom have never farmed – to tell them that water is important. A farmer in the Philippines once told me that his committee was required by the terms of the loan agreement to meet once a week, which was fine if it was a condition of receiving support, but in practice they never had anything to talk about. The other committee members were his neighbours whom he met every day. Like the Andhra Pradesh farmer quoted above, most of the time there was more than enough water. They had always cooperated on water distribution and maintenance as necessary but if water shortage was acute then, as had always been the case, cooperation broke down.

If public money is available, farmers – like any other actors in the rural sector – will do what is necessary to obtain their share, but once funds dry up they typically revert to previous practices. Response to water scarcity and pumping costs provides the primary incentives for efficient day-to-day use; and traditional practices govern seasonal cooperation such as in the management of a village tank or the reconstruction of a diversion weir or silt removal in a common watercourse. No doubt there are benefits to be derived from a more systematic approach to water management but there are relatively few examples where the creation of an elaborate WUA structure proves sustainable. Furthermore, there are other forms of cooperative enterprise open to the farmer, which *have* proved to be sustainable. For instance, few large schemes in India are without a Ryots' Association staffed by men in suits with political access, who have never wielded a hoe in their lives, in contrast to recently promoted WUAs which are typically concerned with small farmers busying themselves with the micro-distribution of water. Ryots' associations bring pressure to bear when major decisions are taken involving serious money or where government decisions impact on the scheme as a whole. And this role has proven its worth.

Fundamental change in Asian irrigation departments can only be expected when the societies in which they are embedded themselves change. A good example is Malaysia, where economic progress has drawn staff away from the department, led to rising salaries, and opened up opportunities for significant improvements. But until this happens on a sufficient scale, not a great deal can be expected. The danger is that institutional and social engineering components in foreign-funded projects will continue to help rationalise donor programmes that in themselves are difficult to justify, no matter what the cost-benefit study concludes, besides leading to waste of effort and resources.

Irrigation Modernisation. If real water use efficiency is relatively high, then – other things being equal – modernisation investments to save water will overstate their benefits. For instance, canal lining other than in saline areas reduces useable groundwater and hence the flexibility of farmer responses; modern control systems subject to major swings in water availability come under great stress as farmers seek access to water when it is scarce and dispose of water when it is abundant; and costly investments that require high levels of technical and managerial performance often deteriorate once donors withdraw. Abandoned pilot projects are scattered through many an Asian irrigation scheme whose proponents failed to assess the realities of local conditions. Amongst these I include myself having revisited a number of South Indian schemes in which I had been instrumental in promoting diversion structures that were new to the region and operational innovations based on unrealistic assumptions relating to the competence and honesty of the irrigation staff and the willingness of farmers to accept significant change. But extreme examples often make the point best and three appalling examples implemented under the AMDP illustrate this well:

The *first* was an Israeli drip irrigation project visited on a hillside in the middle of nowhere far from any airport. Drip lines criss-crossed the fields while the manager told me, in the pouring rain (annual rainfall about 2000 mm), that Sri Lanka was ideally located half way between Australia and Europe for the marketing of vegetables by air.

The *second* was a small US canal control experiment in which it was assumed that, if water could be assured, farmers would close outlets to their watercourses and fields so as to save water. A small tank was supposedly kept full – with priority over other farmers – to guarantee supply provided through a costly piped network. In practice, water poured uncontrolled through the dilapidated system and a stone propped open the head gate. The farmers said they had better things to do than turn taps on and off.

The *third* was a Japanese project on an agricultural research station. The topsoil had been removed to construct a concrete platform on which the soil had been replaced, losing 10% of the area in the process. Having precluded deep percolation (a major feature of Mahaweli soils) the scientists had researched water requirements for paddy. Without a concrete base they feared their results would be ridiculed by their peers.

Of course, there are also examples of success. System modernisation is seldom limited to saving water and can achieve important management and control objectives. Investments in drip and other on-farm technologies have often been profitable notably in private groundwater developments. The point is not to cast doubt on new technologies as such, but to advocate caution in promoting such technologies under the conditions encountered in Asian irrigation.

Conclusion. Irrigation has played a central role in Asia's agricultural development and some readers will conclude that this discussion has been very complacent. Interactions between land, water, food, energy and population are so complex that little is certain. Climate change, population growth, land pressures, trends in commodity markets, and shifts in consumption patterns are among the factors deployed in support of continued investment in irrigation, while the precautionary principle is also advocated given the importance of the world being in a position to feed itself and of individual countries being in a position to guard themselves against rising food prices. The aim has thus not been to devalue the importance of irrigation, but to argue that irrigation in Asia is more productive than is commonly

supposed and to provide a warning that, as argued in this paper, justification for additional irrigation investments can be overstated.

SELECTED PUBLICATIONS THAT EXPLORE SOME OF THE ISSUES DISCUSSED IN THIS PAPER

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