Irrigation Water Pricing

The Gap Between Theory and Practice

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Contents

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Preface

Following the emphasis laid at the Dublin and Rio conferences on treating water as an economic good, much hope has been vested in water pricing as a means of regulating and rationalizing water management.

In the irrigation sector, water pricing has first and foremost been promoted as a cost-recovery mechanism. Users are generally asked to cover recurrent costs so as to ensure the physical integrity of irrigation schemes and their financial sustainability, and perhaps also to pay back a part of the investment cost on economic, equity and/or financial grounds. Pricing has also been promoted as an economic tool, with the aim of eliciting desirable cropping shifts or technological change or even the reallocation of water to economic sectors with higher value added. Lastly, price-based incentives have been promoted as an environmental tool that can contribute to the control of pollution and the sustainability of ecological values.

This book offers a reassessment of this issue. It aims to deepen the understanding of the factors that dictate the effectiveness of irrigation water pricing in practice. It is hoped that this will provide a basis for improving the design of future water policies and for avoiding some of the more costly and misplaced reforms of the recent past. It is based on a comprehensive review of the available evidence and provides an extensive bibliography.

The first chapter looks back at the history of ideas and practices in irrigation water pricing. It flags, in particular, their evolution over the past 15 years and argues that they have in many ways gone full circle back to the consensus that prevailed prior to the Rio Conference. The second chapter synthesizes the lessons learned from the case studies and a comprehensive review of experience accumulated during the past 25 years. It identifies the striking gap between theory and practice, reviews constraints on the effectiveness of irrigation pricing policies, and analyses the scope and potential of differing policy measures. This assessment leads to the conclusion that the scope for irrigation pricing is more limited than has often been assumed.

The introductory chapters are followed by case studies that explore, in a variety of contexts, how pricing policies have been justified and introduced. The case studies evaluate the extent to which these policies have met their objectives, encountered constraints, and - often as not - failed. The case studies illuminate the overriding importance of context. Policies designed on general or ideological grounds typically fail to achieve the benefits anticipated. This calls for a much better assessment of on-the-ground reality before future reforms are introduced.

This book has benefited from the advice and comments of many researchers who, together with the co-authors, have contributed to the material gathered and to the successive reviews of the different chapters. We would like to thank in particular, José Albiac, Randy Barker, Eline Boelee, John Briscoe, Jacob Burke, Anne Chohin-Kuper, Marilyn Clement, Brian Davidson, Ariel Dinar, William Easter, Jean-Marc Faures, Tom Franks, Harold Frederiksen, Colin Green, Abdellah Herzenni, Paul van Hofwegen, Charles Howe, Marcel Kuper, Geoffrey King, Antonio Massarutto, Peter McCornick, Steven Merrett, Marcus Moench, David Molden, Peter Mollinga, Gopal Naik, Chris Olszak, Thierry Rieu, Hubert Savenije, Pierre Strosser, A. Vaidyanathan, James Winpenny and Pietr van der Zaag. In addition, we would like to thank Kingsley Kurukulasuriya for his valuable editorial assistance and Sepali Goonaratne and Mala Ranawake for their secretarial support.

Francois Molle and Jeremy Berkoff
Editors

Series Foreword: Comprehensive Assessment of Water Management in Agriculture

There is broad consensus on the need to improve water management and to invest in water for food to make substantial progress on the Millennium Development Goals (MDGs). The role of water in food and livelihood security is a major issue of concern in the context of persistent poverty and continued environmental degradation. Although there is considerable knowledge on the issue of water management, an overarching picture on the water-food-livelihoods-environment nexus is required to reduce uncertainties about management and investment decisions that will meet both food and environmental security objectives.

The Comprehensive Assessment of Water Management in Agriculture (CA) is an innovative multi-institute process aimed at identifying existing knowledge and stimulating thought on ways to manage water resources to continue meeting the needs of both humans and ecosystems. The CA critically evaluates the benefits, costs and impacts of the past 50 years of water development and challenges to water management currently facing communities. It assesses innovative solutions and explores consequences of potential investment and management decisions. The CA is designed as a learning process, engaging networks of stakeholders to produce knowledge synthesis and methodologies. The main output of the CA is an assessment report that aims to guide investment and management decisions in the near future considering their impact over the next 50 years in order to enhance food and environmental security to support the achievement of the MDGs. This assessment report is backed by CA research and knowledge-sharing activities.

The primary assessment research findings are presented in a series of books that form the scientific basis for the Comprehensive Assessment of Water Management in Agriculture. The books cover a range of vital topics in the areas of water, agriculture, food security and ecosystems – the entire spectrum of developing and managing water in agriculture, from fully irrigated to fully rainfed lands. They are about people and society, why they decide to adopt certain practices and not others and, in particular, how water management can help poor people. They are about ecosystems – how agriculture affects ecosystems, the goods and services ecosystems provide for food security and how water can be managed to meet both food and environmental security objectives. This is the fourth book in the series.

The books and reports from the assessment process provide an invaluable for resource managers, researchers and field implementers. These books will provide source material from which policy statements, practical manuals and educational and training material can be prepared.

Water pricing, especially in the irrigation sector, has been identified as a key policy mechanism to help solve problems of water scarcity and competition. It has been widely discussed and promoted, because in theory it should work. But now after a few decades of experience it is worth assessing the actual practice of water pricing. Is it adopted, and has it been effective, and if so under what circumstances? Are there alternatives to water pricing that will lead to better use of water? This book provides an assessment of current practices, and provides insights on the way forward.

The CA is done by a coalition of partners that includes 11 Future Harvest agricultural research centers supported by the Consultative Group on International Agricultural Research (CGIAR), the Food and Agriculture Organization of the United Nations (FAO) and partners from over 200 research and development institutes globally. Co-sponsors of the assessment, institutes that are interested in the results and help frame the assessment, are the Ramsar Convention, the Convention on Biological Diversity, FAO and the CGIAR.

Financial support from the governments of The Netherlands and Switzerland, FAO and the OPEC foundation for the Comprehensive Assessment for the preparation of this book is appreciated.

David Molden
Series Editor
International Water Management Institute
Sri Lanka

1 Water Pricing in Irrigation: The Lifetime of an Idea

F. Molle and J. Berkoff

Irrigation Financing and Cost Recovery

Providing irrigation always entails a measure of human labour and capital investment. In traditional small-scale systems investments were made by the communities themselves and the initial commitment generally defined rights to access water (Coward, 1980). Such undertakings were often limited (e.g. tapping a spring or a run-of-the-river diversion using a few stones or logs laid across a small stream) but could also be quite costly (as in the case of *qanats*, underground drainage galleries commonly dug over several kilometres). Larger-scale ventures were financed directly by rulers (e.g. river diversions in Mesopotamia or large tanks in South Asia) who derived economic surpluses from the increased production.

The view of irrigated agriculture as a means of ensuring both population needs and generating returns to capital was made explicit during colonial times. Investments in irrigation by the British in Sudan, Egypt, India and Sri Lanka, for example, are all well documented, and income generation and profitability were central concerns. Farmer (1976) observed that in Sri Lanka 'the English government was always concerned, and sometimes obsessed, by the protection and the increase of its income, as was the case in other colonial territory'. Colonial administrators sought both to protect and to uplift the poor masses, when considered to be in a state of misery, and involve them in productive capitalistic investments that would yield net revenues to the Crown (Bastiampillai, 1967).[1] Stone (1984) also documented the endless debates between supporters of irrigation and the guardians of the royal purse.

In contrast to narratives which assume that a focus on the economic value of water was characteristic of a late phase of water resources development, British colonial documents clearly show that most questions currently debated on the economics – perhaps more accurately the financing – of irrigation were already centre stage. The questions of who was to finance the infrastructure (local revenue, the Crown, or private interests), whether and how a water fee should be levied, what its impact on different categories of people would be, whether it should be increased, whether it could influence crop choice or water use behaviour, to cite a few examples, were fiercely debated. Opinions

[1] For example, arguing for investments in the south of Sri Lanka, a British administrator referred to the 'magnificent and really noble and philanthropic, enterprise [to be] accomplished. Nor will it be a barren philanthropy, I mean, in point of pecuniary profit even' (Steele, 1867).

diverged between the British Government, the Government of India and other colonial authorities, local governments, canal engineers, etc., and alternatives such as private investments, bulk volumetric pricing and crop-based differential rates were all tested (Bolding *et al.*, 1995).

The financial (or economic) view of irrigation lost its prominence in the four decades following World War II. Irrigation and dams became pivotal investment options for developing countries, notably newly independent states, to deliver on the promise of feeding the masses, providing income opportunities to rural populations, balancing regional development and alleviating poverty, and hence building self-sufficiency and state legitimacy. Development was seen largely as a matter of infrastructure and technical transfer, and large dams, irrigation schemes, flood control structures and other water projects received massive capital outlays (see Molle and Berkoff, Chapter 2, this volume, and Molden *et al.*, 2007). The national, as well as geopolitical, interests vested in such investments and in the increase in lending by development banks contributed to an outburst of projects, frequently undertaken on political rather than on sound economic grounds (Barker and Molle, 2004). Cost–benefit analyses often remained shoddy and there was limited scrutiny on the assumptions and projections made. All parties involved (governments, local politicians, consultants, construction firms, lending agencies, etc.) had incentives to go ahead (Repetto, 1986; Molle and Renwick, 2005), while the concerned populations were most of the time considered mere recipients of projects rather than partners in their own development. Whether politicians and engineers were infected by the 'desert bloom' syndrome (Carruthers and Clarck, 1981), fulfilled a 'hydraulic mission' through politically rewarding iconic mega-projects or aimed to revitalize an impoverished countryside, free land and water resources were seen as the basic material of agricultural development.

These investments yielded mixed results. Although much was achieved, land productivity, distribution efficiency and management often remained suboptimal, economic returns were often disappointing and environmental externalities (salinization, waterlogging) became more evident with time. Technology alone proved unfit to deal with these growing challenges and attention shifted to organizational aspects, including farmers' participation, turnover and capacity-building. Initially, the World Bank funded only new projects, but poor performance led to a policy shift towards rehabilitation in the late 1960s (Jones, 1995). A first operational policy memorandum (OPM 2.61), issued in 1971, stated that the recovery of all project costs was a normal aim but offered a loophole by adding that 'as a minimum, operation and maintenance costs should be recovered completely' (Jones, 1995). During the 1970s, the questions of why charge, and whom and how much to charge, for water stirred much debate at the World Bank. Proponents of irrigation lending and engineers perceived policy instructions as interference in their job. The prevailing philosophy remained that of 1971, though it was recognized that investment costs might be too high for beneficiaries to pay back and that a 'reasonable' share would be acceptable. Covenant language was accordingly often vague ('. . . to the extent practicable' or '. . . as much as possible') and there was virtually no capital cost recovery (Duane, 1986). An earlier study (W.A. Wapenhans, IBRD, 1969, unpublished data) had shown that 17 projects completed in the 1960s had estimated levels of charge collection that exceeded operation and maintenance (O&M) but only amounted to 29% of full costs.

In 1976, an 'informal discussion paper to assist staff in developing satisfactory approaches to cost recovery' (Ray *et al.*, 1976), followed by Central Projects Memorandum No. 8.4 (World Bank, 1976), defined new overall policy principles and guidelines, stressing three objectives as the basis for cost recovery: public savings, income distribution and economic efficiency. The objective of public savings was to 'enable governments to undertake additional rural development projects that would reach a larger number of the rural poor'. It was also recognized that recovery of all costs might not be possible and that the poor should be identified and exempted.[2] 'Efficiency pricing of irrigation water is usually not possible' but 'even a nominal price for water would offer users some incentive to eliminate at least some of the conspicuous waste and overwatering . . . which occurs when water is treated as a free good' (Ray *et al.*, 1976). Volumetric pricing was desirable but, if not practical, a benefit tax (linked to the land tax), 'although constrained by various administrative and political factors', should be considered a second-best option.

In 1981, the Operations Evaluation Department (OED) released an analysis of 26 irrigation projects completed in the 1970s (World Bank, 1981). Aside from severe problems with water management and maintenance, the survey found that cost recovery covenants had been breached in 11 cases, with no or limited water charges. Reasons included reluctance by government to reduce farm income, cultural or religious resistance, the political clout of farmers and a common 'operational' constraint: 'If project management cannot guarantee continuous and adequate water deliveries to most, or all, project beneficiaries, the Government becomes liable.' While, on the one hand, insufficient attention had been given to differing local conditions, on the other, large discrepancies in the way the Bank handled negotiations with different countries could not be explained by the policy guidelines. Lastly, no relation was found between charges and irrigation efficiency and 'factors, other than water charges, always proved to be much more important in explaining farmer behaviour than the presence, absence or absolute cost of water charges' (World Bank, 1981).

Application of the guidelines[3] in different countries proved difficult. In Indonesia, reinvestment of charges in O&M was hindered by a fiscal problem of flow of funds between central, provincial and local governments, and the willingness to pay was affected by quality of service and by a taxation on rice amounting to 37% of the world price (D. Thompson, World Bank, 1982, unpublished data); in Bangladesh irrigation remained heavily subsidized with benefits accruing to the 'better off' (World Bank, 1978); in some countries studies on farmers' ability to pay were made at the Bank's insistence but their conclusions were disregarded (World Bank, 1981).

The 1976 policy was broadened and simplified in a Policy Note (World Bank, 1984), informed by yet another survey on cost recovery performance. This note distinguished between resource mobilization and allocation and emphasized again the failure to fund O&M, regardless of how much was recovered. It was proposed that assurances should be sought of adequate funds for O&M as a substitute for demanding cost recovery but this was edited out of the final text (Jones, 1995). The lack of incentive for non-autonomous agencies to collect fees or improve management, inadequate collection mechanisms and transaction costs of collecting fees (especially if they were to be volumetric) were listed as constraints. Although the 'longer term objective to have a system of resource mobilization that will recover capital costs so permitting replicability of investments' (World Bank, 1984) remained, most Bank economists were incensed by the weakening of the principle of long-term marginal cost pricing (Jones, 1995).

A further review of conditionality and cost recovery in 1986 confirmed that in only about 15% of irrigation projects were loan covenants fully met and that recovery rates ranged from 0% to 100% of O&M costs, with most in the range of 15–45% (World Bank, 1986). Limited adherence to covenants was ascribed to: (i) the lack of government commitment; (ii) unreliable water supply due to poor O&M of irrigation systems; and (iii) the often heavy burden of direct and indirect taxes already imposed on the farming sector (World Bank, 1986).[4] The lack of relation

[2]It was proposed that an 'indicator of benefits' taken as the incremental gross value minus all incremental costs (irrigation service fees or their equivalent not considered) should be used. Farmers below a critical consumption level (CCL) to be defined would not be taxed.

[3]Reissued with minor changes in 1980 under Central Project Note No. 2.10 (World Bank, 1980).

[4]Preliminary results of the study of the political economy of agricultural policy by Krueger *et al.* (1988, 1991), as well as the review by Small *et al.* (1986), seem to have been influential in bringing this issue to the fore.

between recovery and O&M effectiveness questioned the Bank's emphasis on cost recovery, with Duane (1986) considering the Bank's approach as 'heavily influenced by its thinking about authorities supplying public utilities such as electricity, water for domestic use, etc. which were expected to be self-sustained by commercial revenues'.

The Bank policy had to come to terms with the fact that countries such as India or Thailand were clearly opposed to direct charges, either because irrigation was targeted towards the rural poor and was not expected to be self-sustaining or generate revenue, or because price distortions already siphoned off much of the agricultural surplus (Mexico, Thailand, Sri Lanka, Indonesia, Egypt, etc.) (Duane, 1986; Krueger *et al.*, 1988, 1991; Small, 1990). In 1986, the Asian Development Bank (ADB) also carried out an evaluation of its irrigation projects and came to conclusions similar to those of the World Bank's 1981 review (ADB, 1986a). In most cases, executing agencies had remained in complete or partial default of irrigation service fee covenants.

Management and Cost Recovery

Despite these disappointing reviews, 1986 was notable for a growing consensus that coalesced in a number of converging analyses of the role of irrigation service fees and their relationship to other mechanisms for improving irrigation performance. A World Bank study, for instance, condensed ideas collected from a few country-level analyses and concluded that 'it is time to take a more pragmatic and comprehensive approach to this issue' (World Bank, 1986); the ADB held a regional seminar (ADB, 1986b) and commissioned the International Irrigation Management Institute to carry out a regional study (Small *et al.*, 1986). Concurrently, US Agency for International Development (USAID) commissioned a report on 'Irrigation pricing and management' (Carruthers *et al.*, 1985), and FAO and USAID (1986) conducted an expert consultation on irrigation water charges. Several subsequent papers and reports were consonant with these views (e.g. Moore, 1989; Sampath, 1992; Vaidyanathan,[5] 1992), which were eventually summed up in a remarkable book on irrigation financing by Small and Carruthers (1991).

Although emphasis differed, there was general agreement that water charges alone were an inadequate mechanism for improving irrigation performance and that primacy needed to be given to water distribution and control. Staff members of development banks acknowledged that 'an element of subsidy in irrigation projects is not necessarily sub-optimal' (Ghate, 1985) and that 'bidding for water should not be promoted' (Frederiksen, 1986). The following list by and large summarizes this consensus:

1. *The primacy of management.* Irrigation water charges influence individual farmer behaviour in only a very few on-demand systems. By far the most important mechanism for achieving rational water use is by careful control of distribution and by allocations that broadly meet crop requirements. Fee policies have little or no impact on irrigation system performance (Svendsen, 1986).
2. *Control of supply a prerequisite.* 'Many of the frequently cited inefficiencies of water use in irrigation projects stem more from inadequate control over the distribution of the supply of water than from failure to regulated demand through prices. Supply control can reduce wastage of water associated with excess amounts of water flowing through uncontrolled canals and ungated turnouts onto fields and into drainage channels. It may also encourage more efficient use of water at the farm level by imposing a degree of water scarcity on the farmers. A substantial portion of the large efficiency gains which are sometimes expected from a demand-based pricing system would thus most probably be realized by implementation of the prerequisite supply control' (Small *et al.*, 1986).

[5]In 1992, a Committee on Pricing of Irrigation Water headed by Professor Vaidyanathan (1992) issued a report to the Planning Commission of the Government of India with recommendations regarding the pricing of irrigation water in India.

3. *Financial autonomy.* 'The way in which fees are assessed, collected and expended is more important than the actual level of fees in improving system efficiency and effectiveness. The most critical factor is the level of fiscal autonomy of the irrigation agency, i.e. the extent to which the level of its operating budget is tied to the amount of revenue generated by irrigation systems operations. This provides an incentive for cost-effective goal-oriented performance that is otherwise often weak or lacking' (FAO and USAID, 1986).
4. *Contextualized cost recovery.* The principle of charging for water should be contextualized to consider ability to pay and the overall taxation of agriculture, indirect charges often providing an indirect (but straightforward) means to recover investment costs. Cost of collection needs to be evaluated carefully, price structures tailored to the particular situation and prices indexed. The evaluation of what should be the ideal level of O&M activities should receive more attention.
5. *A contribution principle.* Subsidized water users should repay some of the investments but they should not be asked to repay the cost of 'over-elaborate gold-plated designs, incompetent, expensive construction, cost overruns for reasons of corruption, bad scheduling of construction activities or the like, nor overmanning of the public sector'.[6] While making farmers pay for O&M costs is achievable in most cases, in very few projects (if any) would farm revenues be enough to repay investment costs.

The exception to this consensus was Repetto's (1986) discordant but influential paper on rent-seeking and the performance of public irrigation schemes, which heralded the coming critiques of the 1986 consensus. Repetto convincingly showed how the design and development of irrigation projects were influenced by rent-seeking strategies. From this, he concluded that there was little virtue in objectives other than economic viability, advocating that irrigation projects should be considered as normal investments requiring recovery of full costs, without considering secondary benefits. His analysis of pricing as a means to improve management, however, proved to be weaker: it shrugged off the constraints pointed to by the other studies and extrapolated particular cases, such as private irrigation schemes, to support the generalization of full volumetric pricing and the trading of water rights. Repetto endorsed the model of financial autonomy but in the narrow sense of the utility model, without flagging the difficulties inherent in water allocation and distribution in large-scale surface hydraulic systems.

Repetto's analysis coincided with a growing awareness in the 1980s and early 1990s, in the wake of financial crises and structural adjustment programmes, of the burden on government finances inherited from ever-expanding schemes of dubious profitability. Several countries including the Philippines, Mexico, Morocco, China and Turkey, opted for reforms primarily aimed at shifting part of the O&M burden to the farmers, blended with varying degrees of transfer of management responsibility (see Molle and Berkoff, Chapter 2, this volume). These experiences were sometimes influential but failed to launch a wider dynamic that would have embodied and imposed the principles identified.

At the Bank, the debate was not interrupted by the series of documents issued in the 1980s. The decade ended with a renewed attempt to clarify issues and break away from past confusion; several mistakes from the past were acknowledged (e.g. 'zeal for the fiscal autonomy model' has been insensitive to borrowers' policies and the 'single-minded application [of the model][7] to a second-best world' might not be adequate; establishing boundaries between poor and other farmers to

[6]Rao (1984) estimated that in India only about half of the officially estimated costs should be taken as real costs.

[7]According to Small (1990) the banks' constant concern for cost recovery (despite the fact that payment of loans is guaranteed by governments) is linked to 'a misplaced concern stemming from the importance of cost recovery in private investments, where the inflow of funds to the investor represents the return on the investment. But it is inappropriate to place the same meaning on cost recovery in the case of public investments.'

be charged is 'unworkable') (O'Mara, 1990). On the other hand, emphasis was put again on the priority to be given to physical sustainability, on accepting 'the diversity of cultures and institutional arrangements in borrowing countries' and on basing cost recovery policy on a full analysis of government interventions (O'Mara, 1990).[8]

Water Pricing and Economic Incentives

Although the ideas can be traced back to earlier periods, 1992 marks a convenient turning point in the debate on water pricing: in 1992, the Dublin International Conference on Water and the Environment proposed a set of four principles, the fourth[9] of which underscored that 'managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources'. Although, as seen above, there was nothing novel in the concern with financial profitability, the fourth Dublin principle can be considered a landmark shift in emphasis to the economic dimensions of water use in general and irrigation development in particular. Economic instruments and the economic value of natural resources further found legitimacy in the Rio Declaration on Environment and Development of the United Nations in 1992 (EU, 2000) and its Agenda 21 (United Nations, 1992),[10] which supported the 'implementation of allocation decisions through demand management, pricing mechanisms and regulatory measures'.

More generally, the early 1990s saw the rise of the concept of demand management (which can be defined by 'doing better with what we have' as opposed to continuous supply augmentation), mostly under the influence of resource economists stressing both the economic nonsense of privileging costly and environmentally unfriendly water resources development, and the role and potential of economic incentives in managing demand and reducing the need for additional supplies. The emphasis put on economic efficiency and on the 'user-pay' and 'polluter-pay' principles struck sensitive cords and ushered in heated debates on the right to water, the respective roles of the private sector and local communities, and how to interpret and reconcile the economic and sociocultural dimensions of water.

Conceptually, this period distinguishes itself from the preceding one by a shift in emphasis (Maestu, 2001): earlier justifications of charging for water centred on the financial need for cost recovery to fund further projects (equity), relieve state finances and ensure the physical integrity of, and continued benefits from, irrigation schemes. In the 1990s, water prices, and more generally economic incentives, came to be seen as key policy tools endowed with the potential

[8]O'Mara, Principal Economist at the Agricultural Policies Division (ARD Department), offered his paper as a 'modest effort to clear away the confusion surrounding irrigation policy both inside and outside of the Bank. That there is a need for a policy dialogue within the institution on this topic is increasingly apparent. In its present form, the paper reflects the comments and criticism of many Bank staff concerned with irrigation.'

[9]The full principle reads: Principle No. 4: Water has an economic value in all its competing uses and should be recognized as an economic good. Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.

[10]Principle 16 of the declaration reads: 'National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.' More importantly, Chapter 18 of Agenda 21 stresses: 'Implementation of allocation decisions through demand management, pricing mechanisms and regulatory measures . . . [p]romotion of schemes for rational water use through public awareness-raising, educational programmes and levying of water tariffs and other economic instruments.'

to achieve multiple objectives. With demand management-oriented approaches making conservation a critical issue, the conventional role of prices in managing demand moved from the back seat to centre stage. Likewise, increasing intersectoral competition for water and associated environmental externalities made pricing mechanisms appear as a potential and desirable means to arbitrate water allocation[11] and promote desirable environmental objectives, while maximizing water productivity and aggregate economic welfare. Assigning all these roles to pricing could be seen as the embodiment of the Dublin principle stressing the economic nature of water.

Given this anticipated potential for ensuring financial autonomy of the irrigation sector, cutting state expenditures, eliciting water savings and maximizing the economic efficiency of water use across society, water pricing understandingly attracted increasing attention from policy makers, academics, development agencies and banks (OECD, 1999b). With so much frustration generated by the need for repeated rehabilitation (in Indonesia, for example, one-third of the 3 million ha of government-designed irrigation schemes has been rehabilitated twice in the last 25 years; World Bank, 2005a), by failed attempts to improve water management or efficiency substantially and by incomplete turnover of management to farmers, price instruments appeared to hold the promise of promoting several desired policy goals. In addition, they would provide an elegant solution to long-standing problems, changing behaviour directly through incentives, thus seemingly avoiding the painstaking intricacies of irrigation management, and its technical, social and political ramifications.

This economic rationale soon percolated to water policies. The World Bank's *Water Resource Management Policy Paper* of 1993[12] observed that 'waste and inefficiencies have resulted from the frequent failure to use prices and other instruments to manage demand and guide allocation', and established a powerful narrative around the overarching causal link between water crises, water waste and underpricing. Subsequently, the Bank's policy paper remarked that the value of water differed greatly between agriculture and other sectors, 'often indicating gross misallocations if judged by economic criteria'. It followed that 'setting prices at the right level is not enough; prices need to be paid if they are to enhance the efficient allocation of resources' (World Bank, 1993).[13] Besides continuing to ensure basic cost recovery, price mechanisms were thus assigned the further objectives of reducing water waste, minimizing environmental damage and reallocating water towards higher uses.

The 1990s saw a flourishing literature on the theoretical principles and potential impacts of pricing and water markets, with a leading contribution from the World Bank.[14] During a press conference in Washington on 12 April 2000, James D. Wolfensohn (2000), President of the World Bank, reiterated the view that 'the biggest problem with water is the waste of water through lack of charging'. Johansson (2000) saw water pricing as a 'primary means . . . to improve water allocations

[11]In 1985, concern was only expressed for 'the efficient level of use of scarce water and to its allocation to crops where returns to irrigation are higher', not for sectoral allocation (see Ghate (1985) for ADB's point of view). In the EU 'it is only in the early 1990s that attention started switching to the economic value of water' (EU-WATECO, 2003).

[12]Jones (1995) reports that the elaboration of the paper saw a renewed conflict between economic orthodoxy bent on the long-term marginal-value pricing principle and the view defended by operating divisions, Agriculture Department staff and consultants, who advocated more flexibility.

[13]Identification of an 'allocation stress' became commonplace. For instance, Dinar (1998) held that 'the potential for economic benefits from allocation-oriented institutional change are not only substantial but also increasing with each increase in water scarcity'. Rosegrant and Cline (2002) posited that 'there is considerable scope for water savings and economic gains through water reallocation to higher-value uses'.

[14]See, for example, Teerink and Nakashima (1993); Le Moigne *et al.* (1994); Tsur and Dinar (1995); Bhatia *et al.* (1995); Thobani (1997); Dinar and Subramanian (1997); Easter *et al.* (1998, 1999); Dinar (2000); Johansson (2000); and AMAECO and ANAFID (2002).

and to encourage conservation'. The Economic and Social Commission for Asia-Pacific (ESCAP, 1996a,b)[15] saw pricing as an 'essential component of water demand management', which could in particular 'significantly reduce the wastage of resources'. ADB, in its 2000 water policy, reaffirmed that it 'needs to promote efficiencies in water use by supporting demand management, including water pricing'. Jones (2003) stated that 'anything scarce and in demand commands a price', and that consequently 'water pricing is increasingly seen as an acceptable instrument of public policy'. Finally, the World Water Commission's (2000) report proclaimed that 'the single most immediate and important measure that we can recommend is the systematic adoption of full-cost pricing for water services', although acknowledging that full-cost pricing, long advocated in the irrigation sector, 'has seldom happened'. Other UN organizations and development banks, such as ESCWA (1997, 2005), ESCAP (1981), and AfDB and ADF (2000),[16] usually reproduced these principles and objectives, most of them underscoring cost recovery, but some – including the IADB (1998) and CEPAL (1995) – putting their emphasis on decentralization, water rights and water markets.

These views were consonant with, and perhaps partly derived from, policy shifts in developed countries. The late 1990s saw the gradual elaboration of the European Water Framework Directive which put economic incentives in general and pricing policies in particular at the heart of its objectives of financial and environmental sustainability[17] (see OECD, 1999a, 2002; European Commission, 2000a,b). Interestingly, the use of pricing in the EU policy is advocated primarily as a conservational means to manage demand so as to curb excessive abstraction of water from ecosystems, and incorporates the polluter-pay principle, with water charges being instrumental in internalizing environmental costs. This reflects the weight of environmentalism in promoting economic incentives as key tools for water policy (de Moor and Calami, 1997; Avis *et al.*, 2000; Kaika, 2003; Khanna and Sheng, 2000). In contrast, official references to the sectoral allocation and to charging opportunity costs are rare, although some environmentalists regard full-cost pricing as a way of decreasing demand and environmental damage, since 'the price [of water] could be raised until the level of demand was consistent with the environmental constraints on supply' (Hodge and Adams, 1997), and since 'full cost recovery for water services (should) include the costs of damages to the environment' (Avis *et al.*, 2000).

Numerous analysts have embraced the concept of demand management (Frederick, 1993; Hamdy *et al.*, 1995; Brooks, 1997; Winpenny, 1997; Ahmad, 2000; Louw and Kassier, 2002), seeing its application as a primary means to solve the current water crisis. In turn, central ideas such as the persistence of massive water losses in the agriculture sector, poor management and misallocation of water resources, and the crucial role of economic incentives made their way into the mainstream media including *The Economist* (2003), *Scientific American* (Gleick, 2001), *Science* (Gleick, 2003) and *National Geographic* (Frank,

[15] If properly set and implemented, water pricing for agricultural water could significantly reduce the wastage of resources (ESCAP 1996a). 'Water pricing is an essential component of water demand management which is instrumental in achieving two important goals: to generate revenue for capital recovery, operation and maintenance, extension of the system; to promote efficiency in use; and to protect the quality of water resources by reducing the wastewater discharge' (ESCAP, 1996b).

[16] AfDB and ADF (2000), for example, reads like a textbook of ideal principles, peppered with realism, such as: 'Ultimately, the aim of water pricing should be economic cost recovery, taking into account social equity and capacity to pay by the rural and urban poor. Initially, however, RMCs should target the recovery of full financial costs.'

[17] The 'proposed Water Framework Directive promotes the use of water charging to act as an incentive for the sustainable use of water resources and to recover the costs of water services by economic sector. This will contribute to meeting the environmental objectives of this directive in a cost-effective way' (European Commission, 2000b).

2001). Spurred by the Second and Third World Water Forums, newspapers and analysts also echoed prophecies of the 'coming' (Lavelle and Kurlantzick, 2002), 'creeping' (Falkenmark, 2001), 'impending' (Rosegrant *et al.*, 2002) or 'looming' (IRRI, 1995; UNESCO, 2000) water crises.

These ideas trickled down to policy and law-making in many countries. The 1998 South African Water Act specifies that 'water use charges are to be used to fund the direct and related costs of water resource management, development and use, and may also be used to achieve an equitable and efficient allocation of water' (Republic of South Africa, 1998).[18] Article 19 of the 1997 Brazilian Water law recognizes water as an economic good and introduces water fees with the triple objective of indicating the value of water, rationalizing the use of water and levying funds for the further development of water resources (Government of Brazil, 1997). The 1999 National Water Policy of Bangladesh states that '[a] system of cost recovery, pricing, and economic incentives/disincentives is necessary to balance the demand and supply of water' and that 'water will be considered an economic resource and priced to convey its scarcity value to all users and provide motivation for its conservation' (Government of Bangladesh, 1999; Chakravorty, 2004). Many other state policies or legal acts[19] include similar general principles, or focus on particular ones, such as cost recovery in the case of Vietnam (1998) (users have a 'financial duty and the duty to contribute manpower and budget'), or of the 1988 Law of China (as well as succeeding draft versions of its revision).[20]

The apparent overwhelming[21] adoption of pricing principles created an intellectual environment which made it somewhat difficult for alternative or nuanced voices to be heard. Several papers looking critically at the issue were published[22] and several reviews were carried out though they did not significantly alter the debate.[23] An OED study (Jones,

[18] In addition, they may also be used to ensure compliance with prescribed standards and water management practices according to the user-pay and polluter-pay principles. Water use charges will be used as a means of encouraging reduction in waste, and provision is made for incentives for effective and efficient water use.

[19] This is not the case, however, for all national laws and policies. India (GOI, 2002), Pakistan (GOP, 2002) and Malaysia (FAO, 1996a), for example, do not see irrigation pricing as a water management and policy instrument.

[20] Article 42 stipulates: 'Those who use water provided by water supply projects shall pay water charge to the supplying unit in accordance with stipulations. Water price shall be defined as per the principles of cost recovery, reasonable profit, and good price for good quality and fair shares. The system of accumulative pricing shall be conducted to the water use over than the planned amount.'

[21] Many papers emphasized the emergence of a consensus and the alleged growing application of such principles, contributing to create a 'policy bubble'. See, for example, Johansson *et al.* (2002): 'In addressing water scarcity and increased population pressures many countries are adopting water-pricing mechanisms as their primary means to regulate irrigation water consumption'; Saleth (2001): 'Although water continues to be subsidized in most sectors and countries, there is growing recognition of water pricing as a key policy instrument for cost recovery and demand management'; Jones (2003): 'Water pricing is increasingly seen as an acceptable instrument of public policy.' While these statements are correct in the narrow sense that economic and financial concerns have become more salient and incorporated in policies, they tend to convey an overly optimistic view that economic instruments will be both paramount and effective in achieving multiple long-sought goals.

[22] See, for example, Carruthers and Morrisson (1996), Morris (1996), Perry (1996, 2001a,b), Chaudhry *et al.* (1993) and Perry *et al.* (1997).

[23] For a number of economists, the question was no longer the desirability or possibility of using price regulation but a mere technical debate on how to determine the 'optimal price', for example: 'Despite the pervasiveness of water pricing as a means to allocate water, there is still disagreement regarding the appropriate means by which to derive the price' (Johansson *et al.*, 2002; see Kim and Schaible, 2000; Louw and Kassier, 2002). That prices based on concepts of marginal costs or opportunity costs are invariably found to be incompatible with maintaining farm revenues does not seem to have triggered much theoretical debate.

1995) on 'the World Bank and irrigation' questioned the 'Bank's enthusiasm for irrigation cost recovery . . . [based on] a presumed link between cost recovery and better operation and maintenance', because it confirmed earlier findings by OED that 'there is normally no link between higher water charges and better operation and maintenance. Revenue from water charges generally goes to the general treasury and is not earmarked for O&M'.

'Principled Pragmatism': The Idea Comes Full Circle

Despite the hopes vested in pricing policies during the 1990s, a number of elements have gradually made a reassessment of these expectations necessary. This readjustment has been driven not only by the recognition of a host of technical, socio-economic, legal and political difficulties, which will be analysed at length in Chapter 2, but also by the emergence of severe conflicts caused by raised water charges (or curtailed subsidies) in several countries. The question of charging for water has also suffered from an unfortunate lack of distinction between agriculture and the domestic sector, and many of the conflicts that have bedevilled the latter were mistakenly extended to the former. This may have been partly due to insufficient attention given to crucial differences between the two sectors (see Molle and Berkoff, Chapter 2, this volume), apparent in many policy and academic documents that tend to assume that the two sectors are similar.

The empirical literature on water pricing in irrigated agriculture also yields a paucity of cases in which pricing policies have successfully achieved the objectives assigned to them. First, it has been excessively difficult to raise and stabilize cost recovery from users and in most cases even O&M expenditures are not recovered. There are, however, exceptions. Morocco and Tunisia have, for instance, been successful in covering O&M; Mexico has turned over most of its public schemes (and their related costs) to water user associations; water charges were increased by three times in the 1997 reform of Andhra Pradesh, India, though from a very low level (Samal and Kolanu, 2004); the National Irrigation Agency in Philippines has cut its staff by 75% in the last 25 years (Oorthuizen, 2003); China is experimenting with several ways of delegating water management and strengthening incentives (see Lohmar *et al.*, Chapter 12, this volume), etc. Not all these cases have been unmitigated successes, but they perhaps signal a trend towards better cost recovery, with financial autonomy of irrigation units or projects as a major objective.

The impact of water charges on efficiency has, in contrast, remained almost entirely elusive, as revealed by Bosworth *et al.*'s (2002) recent review of the literature. An analysis of the use of economic tools for demand management in Mediterranean countries also showed that their use in agriculture was far more limited than in the urban sector, and that prices alone did not suffice to elicit significant changes in behaviour (Chohin-Kuper *et al.*, 2002). Compilations of cases such as Bhatia *et al.* (1995), Dinar and Subramanian (1997), Dinar (2000) and Johansson (2000) provide some evidence to the contrary but they are drawn almost exclusively from the urban water sector or from modelling exercises. Examples of changes in cropping patterns and technology are more numerous but these changes are typically caused by a host of interacting factors of which water pricing is seldom of more than marginal significance. Finally, Dinar and Saleth (2005) admit that 'efficient water pricing schemes are rare, if not completely absent, even in economically advanced regions with extreme water scarcity levels, [which] provides sufficient evidence for the persistence of a vast gap between the development of pricing theory and its practical application'; and there also appears to be no example of a country having resorted to administered price setting in order to allocate water among sectors (Bosworth *et al.*, 2002).

A review of OECD countries (Garrido, 2002) concluded that progress in the implementation of water pricing policies had been slow and uneven, and that farmers typically paid only a fraction of O&M costs (and nothing for rehabilitation and amortization of investments, let alone environmental or resource costs). 'Irrigation pricing reforms should not expect significant reductions in farmers' water consumption', and quotas[24] are likely to be required, though prices are expected to contribute to the EU's environmental objective based on the polluter-pay principle (Garrido, 2002). A review of the use of economic incentives (EIs) in Canada (PRI, 2005) noted that 'there has been a tendency to promote EIs as being capable of delivering the best of all worlds: environmental protection, economic and technological development, and revenue generation, while maintaining equity, and all in one convenient box' but 'careful examination of real-life experiences' is needed before these objectives can be assumed to be achieved.

It is thus becoming apparent that on-the-ground evidence of the impact of economic tools remains well short of expectations and promises. Since 2000, several official documents and academic papers have scaled down the earlier enthusiasm for water pricing, reflecting not only the widening gap between theory and practice but also the wish to avoid the violent controversies around this issue (mostly it is true relating to the domestic sector). The Ministerial Declaration of the Second World Water Forum (World Water Commission, 2000) advocates a prudent 'move towards pricing water services to reflect the cost of their provision', but adds that 'this approach should take account of the need for equity and the basic needs of the poor and the vulnerable'.[25] Tellingly, the word 'pricing' is absent from the Bonn Conference 27 recommendations for action, issued in December 2001. Similarly, the 2002 Stockholm statement that, under the title 'Urgent action needed for water security', synthesizes the lessons from the five previous symposia lists four principles for action that do not refer to the use of economic instruments in managing water. Recently, the World Water Assessment Program (UNESCO-WWAP, 2006) stressed the importance of non-economic goals in irrigation, the potential limitations to volumetric pricing and the goal of recovering O&M costs only.

More significantly, perhaps, a recent OED assessment of the 1993 World Bank water strategy concluded: 'Globally, most Bank projects pay lip-service to cost recovery,[26] . . . [and] too frequently, Bank water staff promote reform when the enabling conditions are absent due to the programmatic nature of projects.' In sum: 'Pricing promotes efficiency and conservation . . . but there are few successful examples because of the economic and cultural difficulties of putting a value on a natural resource' (Pitman, 2002). In 2003, the Bank issued a new water resources sector strategy (World Bank, 2003), aimed at updating the document issued 10 years earlier. It acknowledged the 'yawning gap between simple economic principles . . . and on-the-ground reality'.

> It has often been stated that having users pay 'the full cost of water' would solve these problems. Experience has shown that the situation is considerably more complex and nuanced, and that it is not enough to just extol the virtues of pricing. This section outlines a different approach – one of 'principled pragmatism.' 'Principled' because economic principles such as ensuring that users take financial and resource costs into account when using water, are very important. And 'pragmatism' because solutions need to be tailored to specific, widely varying natural, cultural, economic and political circumstances, in which the art of reform is the art of the possible.
>
> (World Bank, 2003)

[24]But 'the use of quotas or allotments suggests that efficient allocation can be made without prices, and that the combination of quotas and cost-recovery charges – not including the opportunity cost of water as the European Union foresees in its Water Framework Directive – may be a viable mix of instruments' (Garrido, 2002).

[25]Interestingly, this political statement appears much more prudent than the World Water Council's two parallel reports prepared for the same forum: 'Making Water Everybody's Business' 'recommends that consumers be charged the full cost of providing water services' (Cosgrove and Rijsberman, 2000); see *supra* for quote from the report 'A water secure World' (World Water Commission, 2000).

[26]Among sectors of the water strategy whose implementation was rated as 'ineffective' were 'allocation issues and opportunity cost of water' and 'transparency and full cost accounting of water delivery service', while 'increasing user charges' was rated 'moderately effective' (Pitman, 2002).

Yet, the soundness of the theoretical background is constantly reaffirmed (World Bank, 2003).[27] Difficulties in implementing water pricing, however, are often ascribed to technical or cultural difficulties, and to political resistance of entrenched sectoral interests (Saleth, 2001; Dinar and Saleth, 2005), and there is a continued hankering for a more ambitious role for pricing. The most recent World Bank initiative for 'Reengaging in agricultural water management' (World Bank, 2005b), however, adopts a more balanced position and states that management of large-scale irrigation has 'been plagued by problems of irrigation service charges, both low levels of charge and low levels of collection'. Where demand is not responsive to price increases and where there is a water shortage, a case admittedly quite frequent, 'rationing (in the short term) or the allocation of quotas (for the long term) should be considered as an effective way to reduce demand and encourage efficiency' (World Bank, 2005b).

It is becoming clear that arguments have often been presented in a very broad manner, with general principles repeated without the necessary qualifications. The literature bears frequent confusion across the board between the different possible justifications for water pricing, and the theoretical arguments that may apply to a particular context are often implicitly or explicitly extended to other situations where they cease to be valid. It is evident, in particular, that there are crucial differences between domestic and irrigation water, classical large-scale surface irrigation and pump irrigation, government and farmer-managed schemes, low- and high-tech distribution systems, staple and cash-crop production, and developed and developing countries. Similarly, parallels with land rights provide limited guidance for addressing water rights (Hanemann, 2006), and comparisons between the water and the power sector can also be misleading.

On a more philosophical plan, the principle of 'water as an economic good' has triggered a heated debate, with the emergence of a concurrent paradigm underscoring water as a social good and/or a human right. This confrontation of world views has introduced a main fault line across the debate (ODI, 2002; Hanemann, 2006). All parties agree that water is the 'stuff of life' and, to some extent, that extravagant consumption is to blame. Those supporting 'water as an economic good', however, see waste as the result of underpricing and, consequently, pricing or markets as a way out of the crisis. They see perfect markets as an optimal means to achieve economic efficiency, as a desirable objective for the society as a whole, and alternatives as second-best options. The rationale for cost recovery, linked to the need to fund maintenance and further expand water services, is opposed by supporters of the 'water as a basic human right' paradigm, who consider that domestic supply is a right that warrants subsidized public investments. They view pricing or market instruments with suspicion, stressing that water is foremost a social good and that its allocation cannot be left to mechanisms that will eventually favour the wealthy and powerful. In their view, prices should be controlled by the government to avoid the commodification of water and the exclusion of the poorest, and only volumes beyond vital requirements should be charged (The Water Manifesto, 1999; Shiva, 2002). Here again, the debate has been obscured by an indiscriminate mix of situations, from little to very water-short regions, from domestic use to irrigation and from individual use to large public schemes.

Controversies and debates along this fault line have increased in recent years. At both extremes, rather uncompromising viewpoints have been expressed, which have not been helpful in building bridges across the two world views. They have stuck, on the one hand to market fundamentalism that seems to be impervious to the lessons of reality on the ground and, on the other, to a romantic posture where water is seen as god-given and should not be sullied by mundane issues of cash. Some, however, seek to adopt more nuanced and conciliatory stances. Despite

[27]The neo-classical principles of pricing and allocation are axiomatic. If at fault, it is because of contextual factors that should be removed, not because the theory should better conform to the real world.

such attempts to bridge conflicting viewpoints, the debate remains fairly polarized.

In the 1990s, the academic literature was dominated by theoretical considerations and promotion of economic incentives as key policy instruments to instil economic rationality and regulate the water sector. Recent publications have focused on the practical constraints faced, besides the inadequacy of some of their theoretical tenets. Without going into the details analysed by Molle and Berkoff in Chapter 2 (and illustrated in the subsequent chapters) mention should be made of the evidence provided by the case studies and literature reviews carried out by Bosworth *et al.* (2002), Cornish and Perry (2003), Hellegers and Perry (2004) and Cornish *et al.* (2004). They stress the importance of distinguishing between objectives and the design of charging systems to meet these objectives according to the context. Volumetric pricing is rare and 'the response in demand to volumetric pricing is widely shown to be minimal'. Water markets have been established in a few locations but bureaucratic allocation of water through price setting is nowhere to be observed; the debate on sectoral allocation may have been misconstrued (Savenije and van der Zaag, 2002) and the degree of misallocation overstated (Molle and Berkoff, 2006).

A balanced assessment has also been issued by ICID (2004) which does not consider recovery of the full financial costs of irrigation but emphasizes the need to define negotiated contractual relationships between providers (of any kind) and users, and to charge the latter the cost of O&M plus renewal costs ('the sustainability costs'). 'Opportunity pricing' has no application in pricing services but the determination of all costs helps in assessing values before allocating resources. Defining quotas may hinder flexibility in reallocation but quotas are equitable and effective in managing scarcity. Dinar and Mody (2004) also observe that financial cost recovery, though becoming more common, is hard to implement. In most cases, they note, pricing does not elicit more efficient on-farm water use, and when it does (often through crop shift or technological change), it does not automatically translate into total water savings. Easter and Liu (2005) focus on cost recovery objectives, ponder on why cost recovery rates are low and acknowledge that water demand may be elastic only at levels of charge that are politically unacceptable. Emphasis is put on participatory and transparent definition of charges and on keeping them within the system, ensuring financial autonomy and enhancing accountability of managers.

In other words, a new consensus is emerging which is by and large replicating the conclusions established 20 years earlier. Charging for water is primarily a fiscal issue on which no general statement can be made as long as it is not part and parcel of a wider financing mechanism, whereby users are effectively empowered and managers made accountable through their dependency on fee collection. Other conservation and allocation objectives remain important but the effectiveness of pricing is limited to some specific 'niches', which can be made to grow but which are likely to remain limited, or marginal, in the foreseeable future. Pricing will generally have limited impact alone but is an instrument that can contribute to a package of incentives. *Principled pragmatism* is needed to apprehend the constraints on the ground, and sound management of supply – at all scales, from the farm to the basin – remains the unglamorous yet fundamental prerequisite to improving the performance of the water sector.

This storyline raises intriguing questions on why the debate has gone full circle in a 20-year period, going through different conflicting views,[28] detours and

[28]As suggested along this historical review, the debate showed considerable wavering between opposite viewpoints and statements: as a rule, cost had to be recovered from users but it was proposed that this could be alternatively done by the government; only direct irrigation benefits should be considered but consideration of induced economic activities was also proposed; subsidies were acceptable and optimum might differ from long-term marginal pricing but strict endorsement of the latter principle proved persistent; the utility model was seen adequate for irrigation service but its clear limitations sometimes recognized; irrigation should be seen as any other economic activity but its other social objectives acknowledged; pricing instruments can target several goals at one time but it is not the case in most instances; etc.

dead ends and finally 'rediscovering' both the limits imposed by the real world to policy instruments and the particular conditions needed for their effectiveness. Although it is not the central objective of this chapter to address this question, one may wonder whether economic thinking, coming to prominence in the late 1980s to early 1990s, has not been subjected to the excessive self-confidence that other disciplines (e.g. agronomy, water engineering, rural sociology and planning) have shown earlier, before being confronted with difficulties in raising yields, improving irrigation efficiency, setting up user groups or implementing integrated development projects or policies. Overconfidence leads to excessive faith in theoretical frameworks, and lack of attention to on-the-ground and political economic factors (Dinar, 2000; Green,[29] 2000). Systematic stigmatization of irrigation as a wasteful sector has frequently been based on a lack of understanding of irrigation management and basin hydrology, just as the domestic and irrigation sectors have been confused, despite crucial differences. Likewise, anti-state ideological rhetoric has often supported the idea that bureaucratic water allocation is insensitive to economic rationality[30] (Moore, 1990; Carruthers, 1997), even where evidence suggests otherwise (Molle and Berkoff, 2006). The issue of sectoral reallocation may have been inflated because of its salience in the USA and also because some economists advocate[31] markets out of ideological inclination rather than sound examination of local contexts (Gaffney, 1997; Bauer, 2004). It is also apparent that the constitution of a massive body of literature, largely fed by a few mainstream institutions and overly self-referential, has contributed to mainstreaming ideas that have often been indiscriminately picked up in national universities or policies, without the necessary caveats and contextualization.

Chapter 2 is devoted to giving flesh to this narrative. It starts with some general considerations on pricing and irrigated agriculture before examining the different policy objectives that can be attained through pricing instruments. For each of these, we attempt to confront the theoretical background with field evidence and assess the scope for achieving these objectives. Getting price incentives in irrigation 'down to earth' by no means negates the importance of prices, or the crucial need for economic insight in the development of water resources. It does, however, assert that – as for all other policy instruments – we should neither entertain unreasonable expectations nor justify or propose policies based on general principles that may not hold in a particular context. When there are good reasons to design financial mechanisms, it does not help to confuse objectives by bringing in arguments of limited validity. Through abundant references to the literature, we will also point to discursive and conceptual shifts and finally identify a range of conclusions which might, hopefully, be contemplated as firm ground for future policy making.

[29]Green (2000) contrasts a Panglossian (optimistic) approach with a 'Pragmatic approach, generally characterised by a concern for institutional design, for increasing public participation and a search for ways of supporting decisions with appraisal tools such as benefit–cost analysis . . . [which] lacks the self-confidence of the Panglossian approach and lacks the glorious heroism of economists riding to the rescue of water management. It is more hesitant in claiming success, hoping instead that instances offer lessons which will improve future decisions'. See also Albiac *et al.*'s (2006) remark that 'water pricing advocated by some government advisors and environmentalists starts to look like "armchair economics"', and Embid-Irujo (2005) on Spain in the 1990s: 'For certain economists or the intellectual colleagues of certain economists, this policy [the setting of a "real" price for water] was a sort of "magic wand" that would solve all the current problems at a stroke, while other experts were more realistic.'

[30]See, for example, Anderson and Snyder (1997): 'Because [water] is so precious, we cannot afford misallocation that comes from political control.'

[31]'Faith in market mechanisms for resource allocation has been "politically correct"—often approaching dogma—for more than a decade. Although attractive in principle, the complexity of establishing markets for tradable water rights should not be underestimated' (Siamwalla and Roche, 2001).

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2 Water Pricing in Irrigation: Mapping the Debate in the Light of Experience

F. Molle and J. Berkoff

Introduction

This chapter provides a broad discussion of water pricing in agriculture, scrutinizes arguments sequentially, gives examples from the literature and indicates links to other chapters. It suggests the conditions under which water pricing is likely (or not) to bear fruit, and assesses its potential for alleviating the global and local water crises. The focus is on public large-scale gravity schemes although groundwater and communal systems are also referred to, albeit in less detail.

Charging for water use or disposal is not an end in itself, but an instrument for achieving one or more policy objectives (Fig. 2.1). A water charge may be *a financial tool* aiming to recover all or part of capital and recurrent costs, recurrent cost recovery being particularly critical to preserve the physical integrity of the system when public funds are not forthcoming. A water charge may also be *an economic tool* designed to conserve water and raise water productivity by promoting: (i) careful management and water conservation; (ii) cultivation of less water-demanding crops and investments in water-saving technologies; and (iii) reallocation of water to high-value agriculture and/or other sectors. Finally, a charge can be *an environmental tool* to counter water pollution and enhance water quality.

Water pricing issues lie at the confluence of two complex 'spheres': on the one hand, the microeconomy of the farm and its linkages to the wider economic system and agricultural policies and, on the other, the hydrology of the plot and its interconnectedness with the irrigation system, the river basin of which it is a part, and the overarching water policy framework (Fig. 2.2).

These nested levels of interaction result in a complex set of dynamics. Economic interactions reflect the multiplicity of factors that govern economic behaviour and the heterogeneity of the different economic actors. Hydrological interactions between upstream and downstream, surface water and groundwater and quantity and quality are compounded by seasonal and interannual variability that creates unstable and unpredictable systems. Economic and hydrological interactions are further embedded within cultural and social contexts that eventually define the distribution of costs and benefits within the society, and are thus highly political in character (Johansson, 2000; Dinar and Saleth, 2005).

In the past, emphasis has typically been placed on influencing the performance of farmers and irrigated agriculture (right sphere) by the manipulation of the

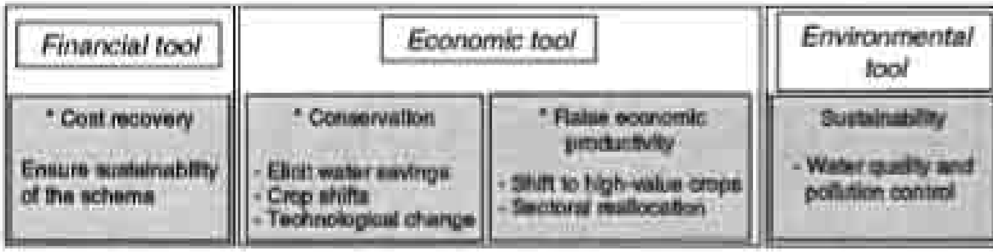

Fig. 2.1. What to charge for?

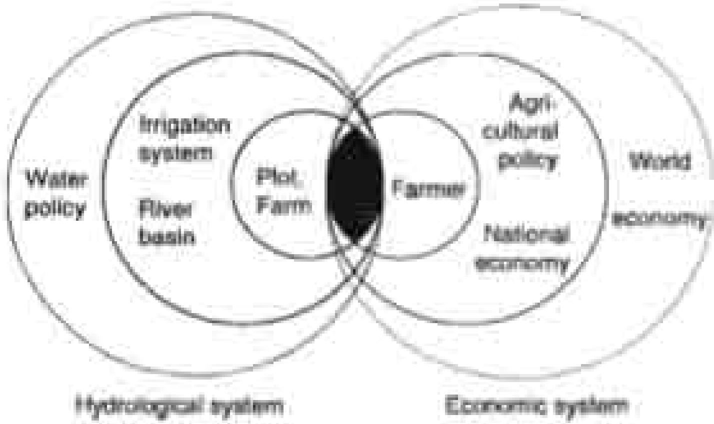

Fig. 2.2. Water pricing issues at the intersection of two spheres of complexity.

hydrologic cycle and the design of canal and pipe networks (left sphere). Increasingly, however, emphasis has shifted to influencing performance of the water system (left sphere) by the adoption of economic and related incentives (right sphere). This chapter reviews the potential and the effectiveness of the latter approach, focusing in particular on the contribution of water pricing. It will argue that water pricing is strongly related to the institutional setting, that is, to the combination of community, government and market regulation, and to the attendant rules that define water governance and management in a particular context. More specialized issues, such as irrigation management transfer, characteristics of water markets, environmental protection, irrigation modernization and politics of water development, though important in their own right and relevant to the issues under consideration, receive less attention in this synthesis chapter, as do related theoretical considerations.

The following section expands on the economic and hydrological systems summarized in Fig. 2.2, and discusses the broad context within which the subsequent discussion is set. Within this framework, we move to examining the practicalities and effectiveness of current water charging practices. The following five sections successively review the main roles commonly attributed to irrigation water pricing: (i) cost recovery; (ii) water conservation; (iii) enhanced water productivity; (iv) intersector reallocation; and (v) control of water quality. The concluding section offers a synthesis of the assessment and corresponding conclusions. While the various sections have been defined for analytical purposes, it will become clear that they are strongly interrelated.

Table 2.1. Evolving priorities of the EU Common Agricultural Policy. (From Gómez *et al.*, 2005.)

	Issues and concerns	Objectives	Agricultural water pricing
Past	Poverty in rural areas Increasing food demand	Equity and rural development Food self-sufficiency	Lower prices
Future	Water and soil pollution Budgetary constraints	Sustainable development Economic efficiency	Higher prices

CONTEXT MATTERS

The Economic Context

The rationale for irrigation

For millennia, subsistence and financial self-interest have driven communities to construct village schemes, rulers to develop major projects and farmers to exploit groundwater and make other on-farm investments. During the colonial period, there were those who hoped the self-interest of private investors would drive large-scale irrigation investment, but few such projects proved commercially viable and major irrigation has remained predominantly in the public sector.

Cost recovery has always been a major concern. Communities internalized costs, historic rulers recruited corvée labour mainly from the farming population and colonial governments constantly debated the optimum balance between profitability and income generation. As described by Molle and Berkoff (Chapter 1, this volume), the balance shifted following World War II. Governments and donor agencies continued to pay regard to profitability, re-expressed in economic rather than financial terms (in cost–benefit studies), and also began to raise environmental concerns. But other objectives were often dominant, notably:

- Poverty alleviation, equity and employment generation;
- Regional development and the urban/rural balance;
- Food self-sufficiency and/or food security;
- State building and the search for political support and legitimacy.

These objectives can, of course, be mutually consistent with one another and with economic optimization and environmental sustainability, and such consistency is often claimed. But where they are inconsistent, choices must be made. Despite lip service to economic optimization and sustainable development, large-scale expansion of the irrigated area has, in practice, been driven largely by political interests reflecting these other objectives. Recently, the balance has shifted back in favour of the environment, at least in the USA and Europe, with implications for irrigation water prices (Table 2.1).

Whatever the rationale given for the initial construction of an irrigation scheme, subsequent cost recovery remains a widely accepted policy. In practice, cost recovery is normally limited to the recovery of operation and maintenance (O&M) costs and at most to a (small) share of capital costs. The main driver for cost recovery has been containment of government costs, though recouping at least some of the costs from direct beneficiaries is also advocated on equity grounds. In addition, it is claimed that charging for water can promote favourable economic and financial outcomes, especially if combined with irrigation management autonomy. Some commentators have gone further, arguing that irrigation pricing can lead to economically efficient outcomes. Although such claims are now largely discounted (Molle and Berkoff, Chapter 1, this volume), the idea remains important and is explored later in this chapter.

Cost–benefit analysis

Cost–benefit analysis ostensibly provides the basis for taking decisions on public investments. Standard approaches allow for the adjustment of financial prices as a basis for choosing economically viable projects, with additional studies throwing light on possible economic distortions.[1] The main direct costs are the initial capital costs, which typically account for 80–85% of discounted total costs in surface irrigation. Recurrent costs comprise a higher share in pump schemes though capital costs still largely determine viability. Once built, capital costs are '*sunk*' and the direct marginal costs comprise regular O&M together with the costs of replacement, rehabilitation and modernization. Indirect costs include negative environmental and social externalities and opportunity costs – if any – reflecting an appropriate share of the value of output forgone in alternative uses (see below). The main direct benefits comprise the incremental value of agricultural output *with* relative to that *without* the project. There may also be benefits from domestic supply and other uses, and from positive externalities. If discounted benefits exceed discounted costs, the project is viable.

Although cost–benefit analysis is, in principle, straightforward, its application in irrigation and other water projects has been problematic. Although some claim that ex post evaluation studies show that irrigation projects have performed satisfactorily (Jones, 1995), others suggest that there has been a systematic bias in favour of new construction (Repetto, 1986; Berkoff, 2002; Molle, 2007). Three types of argument support the latter case:

- First, as suggested above, political objectives rather than economic priorities often drive irrigation expansion. Moreover, the political dynamics almost always favour going ahead given the combined self-interest of beneficiary farmers, politicians, contractors, consultants and staff in irrigation, and lending agencies (Repetto, 1986; Merrett, 1997). Finance and other entities serving a broader national interest may restrain irrigation expansion, but can seldom prevent it, even if that is their preference.
- Second, the economic analysis of irrigation is more than usually uncertain. Unwitting optimism is widespread and over-optimistic assumptions are difficult to refute, both with regard to costs and to benefits. 'Costs tend to be high because of: inappropriate design, stemming in part from poor studies done prior to start-up; long gestation periods resulting from funding shortfalls due to changing government priorities and poor capital programming and budgeting; few managerial incentives to control costs; and reported corruption that typically involves kickbacks from construction companies' (Holden and Thobani, 1996). Benefits comprise the difference between two large hypothetical future flows (the values of production *with* and *without* the project). Estimating these flows is based on a host of assumptions that cannot be readily validated (Carruthers and Clarck, 1981; Merrett, 1997; Green, 2003). If prices, yields, irrigation efficiency or cropping patterns are adjusted even modestly, the impact can be surprisingly large. Who is to say the assumptions are wrong?
- Third, the retention of surface irrigation in the public sector and the funding of surface irrigation from the government budget limit financial accountability and help explain why inadequate cost–benefit studies generate such little concern. Canals and related facilities are often classified as infrastructure comparable to roads or power supply, and governments feel responsible for infrastructure. But irrigation is also a productive activity in many ways analogous to industry. Few governments still feel competent to *pick winners* in the industry, yet this is rarely questioned in irrigation.

Cost–benefit analysis is thus malleable, and analysts are invariably under pressure to produce positive results. Feasibility studies that appear competent at the time often prove very over-optimistic in retrospect (Pitman, 2002). Re-estimated rates of return are thus typically much lower at completion of project works than at the feasibility stage, and lower still at impact assessment when actual performance outcomes are available. Moreover, long-term price trends, system deterioration and failure

[1] For example, nominal and effective protection studies.

to account adequately for the *without* case suggest that – even at impact assessment – over-optimism is rife (Berkoff, 2002).

Overriding national priorities

The use of social weights and an opportunity cost for labour are techniques that can, in theory, help address issues of poverty alleviation, equity and employment in cost–benefit analysis (Squire and van der Tak, 1976). These partial equilibrium approaches are, however, controversial, given also the inherent uncertainties described above. Moreover, it is arguable that they do not account adequately for broader issues. Irrigation has both backward and forward linkages, while enhanced incomes have further multiplier impacts. Large-scale irrigation is thus often promoted as the engine that drives rural development as a means to both alleviate poverty and provide job opportunities so as to limit outmigration to cities. Such regional development issues are, in theory, best addressed in a general, rather than a partial, equilibrium context. General equilibrium models are, however, complex and expensive, and well beyond the scope of most project studies. Some advocate a simpler approach, that of increasing benefits by some factor representing multiplier impacts. But, for this to be valid, multiplier benefits should be confined to *incremental* impacts relative to those of the next best alternative, allowing also for opportunity costs and the avoidance of double-counting (Carruthers and Clark, 1981; Gittinger, 1982). It is arguable that such conditions occurred in densely populated Asia at the early stages of development (say, 1950–1980) when other viable regional projects were scarce and labour and water were abundant relative to land. Whether such conditions prevail today, notably in land-abundant Africa and Latin America, is much more questionable. Farmers in these regions often have access to rain-fed lands, population densities are much lower and conventional returns to irrigation have declined drastically.

Even if the case for new irrigation based on multiplier effects is questionable, they may still provide a rationale for *preserving* irrigation that has already been built. If investments in transport, marketing and social infrastructure depend on irrigation for their continued profitability, the case for preserving irrigation as a form of social overhead capital comes into its own (Small, 1990). On the North China Plain, for instance, irrigation is affected by severe water constraints. Water transfers from the Yangtze will help maintain farm incomes and slow rural depopulation. Although new irrigation cannot be justified on economic grounds, the economic returns to the transfer to sustain existing irrigation are strengthened by the costs sunk in existing assets not only in irrigation facilities, but also in rural economic and social infrastructure (Berkoff, 2003a).

Irrespective of these economic arguments, history shows that many schemes have also, in practice, been designed with wider geopolitical motives in mind. The western USA, for instance, illustrates a long history of engagement by the state in support of colonization (Reisner, 1986). The Gezira scheme in Sudan (Gaitskell, 1959), Israeli settlements in Palestine (Lipchin, 2003) and the GAP project in southeastern Anatolia (Harris, 2002) are other well-known examples of projects promoted to achieve geopolitical goals (Molle *et al.*, 2007). Likewise, the context of the Cold War and the food shortages and fears of rural disintegration that followed the El Niño-related climatic perturbation of 1972 did much to justify the huge investments in dams and irrigation infrastructures that were to follow (Barker and Molle, 2004). Food self-sufficiency or food security has often been a top strategic concern to be addressed at any cost. In such situations, economic or hydrologic rationality is in effect neither here nor there and overriding political decisions dictate public investments.

Shifting subsidies and taxation

Moreover, the public subsidies incurred under such rural development policies need to be placed in a general economic context. In the decades after World War II, many countries adopted a policy of taxation of agriculture, notably by export duties (Harris, 1994) and public procurement programmes that maintained farm-gate prices often well below their world price equivalents. The magnitude of this taxation amounted – to borrow from Schiff and Valdés (1992) – to a 'plunder' of agriculture during 1960–1985. In Mexico, the price distortion amounted to an implicit tax of 20–50% of the value of the project commodities (Duane, 1986) and similar state extractive policies were carried out in most developing countries, including Egypt (Barakat, 2002), Thailand (Molle, Chapter 5, this volume), Malaysia (World Bank, 1986), Pakistan (Chaudhry *et al.*, 1993), Côte d'Ivoire, Ghana and Sri Lanka (Krueger *et al.*, 1991; Schiff and Valdés, 1992). Low food prices benefited the urban poor and landless, and taxes on output generated public savings for investment in industrial and urban development, only partially offset by irrigation and other rural subsidies (Lipton, 1977). Low food prices also had adverse impacts on crop output so that rationing was often required to manage consumption, limit imports and maintain food self-sufficiency.

Over time, the arithmetic of relative taxes and subsidies changed drastically as world prices declined and incomes rose. This and the widespread adoption of liberalization policies led to the abolition of most export duties and food-rationing programmes. Reforms initially boosted farm output and incomes as farmers responded to liberalized markets and exploited the agricultural technologies open to them. But as prices declined further, and as economic growth and diversification took place, urban/rural income differentials were reaccentuated, often provoking farmer unrest. Fearing also adverse impacts on domestic output,[2] some governments (e.g. China and India) have begun to support (rather than – as in the past – tax) farmers by limiting imports and adopting other trade-distorting measures. In this they have followed the lead of developed countries (the EU, the USA and Japan) that have long protected agriculture. This situation helps explain the reluctance of governments to raise water charges or other input prices for fear of losing their competitive edge (Tiwari and Dinar, 2001), since many farmers have to compete with exporters from the North who benefit from lavish subsidies.[3]

These trade distortions (market access, tariffs and export subsidies) are the major concern of the WTO Agricultural Agreement (WTO, 2000). Their removal would raise farm-gate prices significantly by reducing developed country exports, thus moderating the need for interventions by developing country governments in support of their farmers, besides facilitating attainment of food self-sufficiency objectives and promoting developing country food exports and inter-south trade (USDA, 2001). The WTO agreement also aims to reduce direct food and fertilizer as well as other input subsidies that have a direct impact on trade. In contrast, irrigation expenditures are amongst those that can be used freely since it is argued that they have minimal impact on trade (WTO, 2000). This is perhaps debatable. It is true that viable irrigation projects do not distort trade but if – as suggested above – much irrigation has been uneconomic, cumulative worldwide irrigation subsidies have contributed to declining world prices in a manner comparable to that of other trade distortions. Moreover, although irrigated output has risen enormously, rain-

[2]Taxation of agriculture and the resulting 'urban bias' are also seen as reflecting the shifting influence and political clout of interest groups and coalitions (whether defined by sector or income groupings) (Lipton, 1977; Bates, 1981; Sarker *et al.*, 1993), linked to their income, information and education, potential for collective action and political representation (Binswanger and Deininger, 1997). According to Bates (1993) this transformed the agriculture sector from 'an embattled majority that is taxed into a minority powerful enough to be subsidised'.

[3]Yang *et al.* (2003) show how decreasing profitability could put further pressure on domestic food production in China, challenged by international markets since the late 1990s, and even more since China's recent accession to the World Trade Organization (WTO) (Huang and Rozelle, 2002). After adhesion to the WTO, Jordan had to face 'unfair market intrusions by countries with less stringent WTO membership conditions' (WTO, 2001) and realized that abolishing subsidies altogether would be detrimental to its own farmers.

fed yields and output may well have been suppressed (Berkoff, 2003b). If so, food self-sufficiency based on irrigation may have been achieved at the expense of the rain-fed farmer.

Ultimately, all tax and subsidy polices are conditioned by politics, and reflect the cultural, economic and political milieu in each country concerned. Although the WTO negotiations aim to moderate economic distortions, and thus benefit those that are discriminated against, especially by developed country interventions, all such interventions must be understood within the wider political and policy context if they are to be analysed and possibly changed (Sampath, 1992; Speck and Strosser, 2000).

The Hydrological Context

The characteristics of water and water use

The physical characteristics of surface water are well known and include site-specificity, mobility, stochastic variability and uncertainty, bulkiness and solvent properties. Accompanying these are its relatively low value as a commodity, the economies of scale that often make supply a natural monopoly and the pervasive interdependence of water users (Young, 1986; Livingston, 1995; Morris, 1996; Savenije, 2001; Green, 2003). Groundwater shares some of these attributes but has other attributes that set it apart, including its relative immobility, security and divisibility.

Water has numerous human uses, some of which are consumptive (agriculture, industry and domestic) and others non-consumptive (fisheries hydropower, navigation, etc.). Water also has environmental values that are appreciated by humanity. The characteristics of water use in agriculture set it apart in many ways from its use in municipal and industrial use.

Diversions for consumptive use are invariably larger than the fraction that is actually consumed, with the balance returning to the water system. Agricultural withdrawals (predominantly for irrigation) account worldwide for 70% of the water withdrawn for consumptive use (Aquastat, 2004). Its share is typically higher in developing than in developed countries. Evapotranspiration accounts for 40–60% of agricultural withdrawals (rising to above 70% due to repeated reuse, modern irrigation techniques, etc.). In contrast, domestic water withdrawals are largely used for washing and cooking, and domestic diversions largely return – often in a polluted form – to the water system. Similarly, industrial diversions are mainly for cooling and dilution of wastes rather than for chemical incorporation in products. Consumptive use as a proportion of withdrawals is thus much higher in agriculture (70%) than in domestic (14%) or industrial (11%) use, and agriculture accounts for as much as 85–90% of total consumptive use worldwide (Shiklomanov, 2000).

Uses in the municipal and industrial (M&I) as well as the irrigation sectors are not always fully interchangeable. M&I use is usually far more valuable than in irrigation, and logic implies that water should move wherever possible from irrigation to M&I in the event of conflict. But transfers are only feasible if the infrastructure is, or can be, integrated at acceptable cost. Moreover, M&I have much higher quality and security-of-supply requirements than irrigation, which may limit transfer opportunities.

Consumptive use impacts on non-consumptive uses through its effect on flow regimes, water quality and flood risk. Given that irrigation use is so much greater than M&I use, the major quantity conflicts are generally between irrigation on the one hand and in-stream and environmental uses on the other (though M&I can have large quality impacts). Irrigation diversion capacity often exceeds dry season flows and, as use rises, irrigation may be able to divert flows year-round. In-stream uses suffer, rivers and wetlands dry up, affordable groundwater is exhausted and pollution loads rise (though flood risks may moderate). Action to safeguard in-stream and environmental uses may then become desirable and, in effect, irrigation rather than the environment becomes the *user of last resort* (Elston, 1999).

Irrigation efficiency

The concept of irrigation efficiency is often misstated (Willardson *et al.*, 1994; Frederiksen, 1996; Keller *et al.*, 1996; Huffaker *et al.*, 1998; Perry, 1999; Huffaker and Whittlesey, 2000; Loeve *et al.*, 2004; Molle and Turral, 2004) with significant implications for water pricing. If water is abundant, scheme-level efficiency is of limited concern other than for system capacity and capital cost reasons. If basin water is scarce, raising scheme efficiency can be elusive since return flows are fully utilized and the only *additional* source of water lies in reducing unproductive losses.[4] In north China, for instance, apart from uncontrollable floods and releases for silt and pollution control, little water reaches the sea from a vast area containing up to 7.5% of world population. Drainage and wastewater reuse are pervasive, losses recharge groundwater, farmers underirrigate, tail-end areas are abandoned and basin efficiency is high by any standards. Existing irrigation can essentially absorb *all* the water available and shortages relative to theoretical crop water requirements have little meaning (Berkoff, 2003b).

It is not only basin efficiency that is misstated. Scheme and on-farm efficiencies are also often (much) higher than assumed. That water is 'wasted' when it is abundant (e.g. after it rains) is inconsequential – low physical efficiency may even correspond to high economic efficiency since management is eased and labour reduced (Gaffney, 1997). In contrast, farmers fight for water and return flows if it is scarce (and over-pump groundwater). The struggle for water *when it is scarce* means that little water is wasted *when it has value* and average estimates of efficiency can be very misleading. Case studies from Thailand (Molle, 2004), California (Zilberman *et al.*, 1992) and China (Loeve *et al.*, 2003) have shown the multifarious efforts deployed by farmers to adjust to water scarcity and make the best use of water. These changes go often unnoticed but statements such as 'farmers waste water just because [they] are not aware of the fact that water has a value' (Roth, 2001) are both unfair and mistaken. Moreover, even if there is potential for increased scheme-level and on-farm efficiency, this can require expensive investments in drip or sprinkler systems that may not be justified either financially or economically.

Irrigation design

Opinions on irrigation design range from those that advocate modern systems of control (Plusquellec, 2002) to those that advocate simple technologies that respond to human and institutional limitations (Horst, 1998; Albinson and Perry, 2002). The critical factor is stochastic water variability: from day to day, week to week and year to year. *Supply* is variable because runoff is variable; *demand* is variable because rainfall and crop water requirements are variable. Reservoirs and groundwater improve predictability, and on-demand systems help farmers obtain water when it is needed. But in practice, most surface water systems are designed to meet peak water requirements for a specified cropping pattern, say, 3 years in 4 (i.e. the 75% year) (the full area being irrigated in the wet season and a restricted area in the dry season). This is a compromise. If greater security is guaranteed to a smaller area, in most years the available resource is underutilized. If canal capacity is increased to expand the area in good years, unit costs rise, security declines and capacity in most years

[4] That there is little water – if any – to be saved in closed basins must, however, be qualified since there are notable exceptions. If return flows from irrigation are degraded in terms of quality (salinity, contamination), they may incur yield losses when reused (Morocco: see Hellegers *et al.*, Chapter 11, this volume; Pakistan) or be unfit for agriculture (e.g. Jordan Valley: Fontenelle *et al.*, Chapter 7, this volume), and therefore losses should be minimized. If the time taken by water to become available again is very long (e.g. percolation to deep aquifers), these volumes are not available for short-term use. Water wasted in the wet season in cities or irrigation schemes could also sometimes be kept in reservoirs for later use in the dry season. Another caveat concerns the costs incurred by possible successive pumping operations associated with reuse.

is excessive. In contrast to fully on-demand systems, therefore, it is *by design* that the full area cannot be irrigated in dry periods, in dry years and during the dry season.

As economies develop, shortages increase, water tables fall, other users get priority and variability is increasingly concentrated on irrigation as the residual user. Both the value of water and the costs of insecurity rise. Reservoirs are built, farmers install wells and on-farm ponds and modernization and volumetric measurement become affordable. Operator salaries and skills also rise in line with general living standards. In other words, irrigation responds to the external context. Ultimately, the issue in irrigation design is not that it is innately different to M&I design, but that there is a continuum from simple surface systems suited to low-return agriculture in poor countries, through conjunctive use and partially modernized systems appropriate to countries moving through the rural transition, to advanced technologies appropriate to high-return agriculture in richer countries that are completing the transition. At the limit, design approximates to that for M&I, and volumetric measurement at the level of the individual farmer becomes feasible. Until this point is reached, physical characteristics of irrigation severely constrain the possibility of using efficiency (marginal cost) pricing, and the debate on how economic pricing can be introduced has, in general, been a distraction.

Irrigation performance

Irrigation performance also ranges through a continuum. Traditional systems can be stable, but crop yields and farm incomes often remain low. Productivity and income in public systems are normally higher and manageability improves as an economy develops, agriculture becomes more entrepreneurial and market-driven, farm sizes and incomes rise, O&M agencies are better-funded and accountable and storage and modern control become affordable, manageable and justified.

Nevertheless, despite these trends, in the view of most observers, irrigation performance in developing countries remains generally poor. Water variability is again the main reason why so many schemes are so difficult to manage. *Ex post*, management must respond to conditions that deviate continuously from the average conditions implied by a design cropping pattern that means little to the farmer. Irrespective of design intentions, the farmer typically *wants* more water than he is allowed in the dry season and in dry periods; after rainfall, he may reject his allocation even if this causes problems elsewhere in the system. Differing objectives set up a continuing tension between scheme managers and farmers. Farmers interfere in outlets and water levels contributing to head-end and tail-end problems, while poorly paid system operators living close to the farmers fail to enforce – perhaps cannot or do not want to enforce – the rules. On the one hand, water-use efficiency is enhanced as farmers struggle for water and, on the other, damage is pervasive, inequities emerge and there is a broad failure to operate the system in line with design.

A Typology of Irrigation Systems

Figure 2.3 suggests a simplified typology of irrigation systems that reflects the above discussion. It classifies systems in relation to an index of relative water supply (RWS)[5] and suggests two broad types of management response: *pragmatic management* and *volumetric management* (that are linked not only to the degree of development, but also to the climatic context). With respect to Fig. 2.3:

- Situation W1 is typical of wet regions with abundant water supply. Water tends to be supplied continuously – often for paddy – at, or close to, full supply level, though rotations can be necessary if main canal capacity is a constraint. Occasional shortages may occur due to ill-discipline and farmer

[5]RWS is defined as the ratio of the water delivered to gross irrigation requirements (net of the effective rainfall) after accounting for losses. It provides a broad indication of the amount supplied relative to demand.

intervention. Minimal data on flow, rainfall and land use are typically collected.

- Situation W0 typifies non-arid countries as water is increasingly exploited. Operations reflect experience rather than active management, with water often released in response to farmers' complaints. Head-end and tail-end problems are limited while temporary supply reductions can lead to short-term crises as discipline breaks down. Data are collected haphazardly and seldom analysed. As RWS falls to 1, conflicts intensify and rotations are increasingly adopted.
- As RWS drops below 1 (D0), rotation becomes the rule. Farmers respond by deficit irrigation and conjunctive use (tapping drains, ponds or aquifers) and use water more carefully. Head-end and tail-end problems become pervasive. Data are collected more systematically and basic parameters (efficiency and water applied) are calculated. Supply-driven management predominates with scheduling planned, based on target allotments, and bulk allocations may be negotiated.
- Under situation D1, potential demand cannot be met and supply limits allocations. If the system is uncontrolled, water distribution may be chaotic. Groundwater replaces surface water and conjunctive use is ubiquitous, with land left fallow or abandoned. In systems that are better controlled – depending on design – water is confined to part of the scheme, supplied in turn or allocated proportionally (as under warabandi).* In fully controlled systems, volumetric rights are clearly defined and water may be supplied on demand, subject to availability.

When RWS falls below 1, the crucial step is the shift from 'pragmatic' to 'volumetric' management (Fig. 2.3). *Pragmatic management* is weak, reactive and ad hoc, with managers responding to complaints from below and farmers responding as best they can, e.g. by investing in wells and on-farm storage. As scarcity develops, water distri-

*All systems have to cope with hydrological variability (i.e. varying values of RWS) but both demand and supply are more predictable in arid climates since rainfall is a less significant factor and reservoirs are the norm. In humid climates, rainfall is a much more complicating factor since it strongly influences not only supplies at the source, but also requirements in the fields.

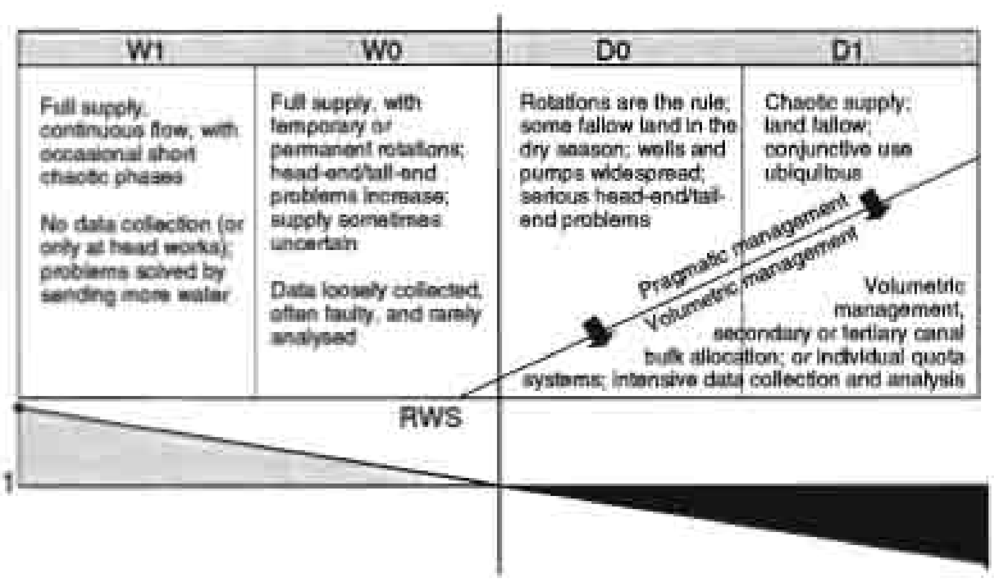

Fig. 2.3. A typology of irrigation systems.

bution becomes increasingly chaotic. Such conditions are common in developing countries, especially when schemes are large, farmers are numerous and poor and surface irrigation is dominated by cereals and low-return crops. Under these conditions, head-enders tend to divert what they want and tail-enders often fail to obtain even minimal supplies. With *volumetric management*, in contrast, a stronger degree of control is maintained. Water may be allocated in bulk or by individual quotas, rotational rules are clear and roughly predictable and risks are defined. At the limit, water may be provided approaching on-demand supply. This situation tends to occur in developed and/or arid countries, especially when farms are large, irrigated agriculture is for high-return crops and farmers incur large on-farm costs and financial risks (see above). Security in supply invites complementary on-farm investments and tends to make farmers willing to pay for water since even high charges comprise a small share of farm costs and service standards are critical.

This classification simplifies real-world diversity and variability. Even so, it can provide guidance in assessing the potential of water pricing policies. The difference between pragmatic and volumetric management corresponds to a 'quantum leap', and efficiency pricing is only possible if the scheme is under volumetric management and control is maintained. Many reforms fail because they assume very lightly that shifting from the former to the latter is simply a question of goodwill or capacity building, whereas it is linked in complex ways not only to RWS, but also to irrigation design and hydraulic control, manager-incentive and farmer-incentive structures and the wider institutional context.

Implications for Irrigation Pricing

Full marginal cost pricing

By analogy with domestic water supply and other infrastructural services, some analysts recommend long-run marginal cost (LRMC) pricing in irrigation (Arriens *et al.*, 1996). But there are important differences between the sectors. One issue is that volumetric pricing is far more problematic in irrigation than in reticulated urban systems, and this greatly restricts the adoption of efficiency pricing in irrigation. Basically, LRMC pricing in the urban sector simulates a competitive market price for a final good and, besides funding recurrent, replacement and related costs, it aims to generate the investment funds needed to match rising demand as a city expands and its population becomes richer (Munasinghe, 1990). If consumers are willing to pay the LRMC price, system expansion is economically justified; if not, effective demand can be met by existing capacity.

In contrast, irrigation water is an intermediate, not a final, good, and canals are sized to serve a specific command area at defined levels of probability (see earlier section). Possibilities for system expansion are thus restricted. Since charging existing farmers for a new scheme is no more justified than charging City A's inhabitants for expansion of City B's system, initial capital costs should usually be treated as *sunk*, in which case marginal direct costs comprise O&M and replacement costs.[7] Of course, if the scheme is inherently profitable, farmers should, in theory, be able to repay full costs (including initial capital costs), and charging them less than full cost gives them a windfall gain. But if expansion of irrigation has been driven by other public objectives (see above) and is uneconomic, charging full capital costs is neither feasible nor equitable (Carruthers and Clarck, 1981). Moreover, over time, capital subsidies are incorporated in land values and, though the initial beneficiaries may receive a windfall gain, inequities arise if charges are imposed on those that subsequently buy irrigated land.

Irrespective of any theoretical rationale for marginal cost pricing, there may still be a case for charging farmers a share of initial capital costs on financial and equity grounds, given

[7]They should also, in theory, cover modernization and system expansion costs if the water saved by the modernization investments is justified specifically in terms of the expansion of the scheme. The analogy with LRMC in expanding urban systems is then valid.

the needs of the economy and adverse impacts on rain-fed farmers. There is also the quite separate issue of whether opportunity values in alternative uses and externality costs should be reflected in some way in the irrigation charge. But competition between irrigation and cities is limited to specific periods and locations and, once urban demands are satisfied, opportunity cost falls drastically. Beyond compensating farmers on a case-by-case basis, water pricing to promote reallocation is generally impracticable (Molle and Berkoff, 2006; more on this later). Once M&I use is met, most conflicts lie between irrigation and the environment. But valuing environmental *externalities* (third-party impacts, soil salinization, water contamination, health hazards) is also a contentious issue, and willingness-to-pay for moderating such costs varies greatly at differing locations and stages of development. In most cases, there is no agreement on how pricing can mitigate negative impacts, and reflecting environmental use and valuing externalities are again impracticable (see section *Pricing as an environmental tool*).

The relevance of marginal cost pricing

Moreover, the need for strict marginal cost (efficiency) pricing in practice is often questionable. As argued above, irrigation performance typically reflects a rational response by farmers and operators to the evolving context and associated incentives. Water is used much more efficiently than is commonly supposed, and the scope for enhanced water-use efficiency and the potential role of water pricing can be greatly overstated. Furthermore, the massive expansion of private groundwater, much of it within surface schemes, has further strengthened irrigation performance. Groundwater is, in effect, available on demand and provides a security of supply that can offset variability of rainfall and canal supplies. Groundwater use, or conjunctive management, has thus accounted for most of the high-return diversified agriculture that has developed in response to economic growth, urbanization and external markets, and groundwater's pervasiveness limits the need for surface irrigation to meet these diversified demands.

In addition, no administered price can reflect short-term stochastic variability and, though at the margin water charges may impact on farmer behaviour and promote favourable economic and financial outcomes (Fig. 2.1), this is far short of true economic efficiency pricing. Modern control systems may be justified and, at the limit, a pressurized on-demand irrigation system approximates to a reticulated urban network. But, while urban systems are, in principle, *designed* to operate on demand, the vast majority of surface irrigation projects *by design* cannot supply water on demand since they cannot meet potential farmer uses when water is scarce (e.g. in the dry season or a drought). Comparing benefits and costs at the margin is therefore meaningless because farmers cannot, like urban users, access as much water as they wish and are willing to pay for. These considerations suggest that efficiency pricing is usually impracticable even in fully reticulated systems; supply management and rationing will inevitably remain the preferred mechanisms for controlling surface distribution in most irrigation in developing countries.

Potential price effects

As empirical evidence will confirm, the economic and hydrological characteristics reviewed above impact on irrigation water pricing in such a way that water charges are eventually, first and foremost, a cost-recovery mechanism. Even confining water charges to this one objective is far from straightforward since, as discussed above, what is meant by cost can vary depending on whether costs are limited to financial costs or extend to the full economic costs to society (Rogers *et al.*, 1998) and what is to be recovered may be limited to recurrent and replacement costs or include some or all of the capital costs invested. Financial O&M costs are invariably a priority since, once a scheme is constructed, production is contingent on continued O&M of the infrastructure.

In addition to financial cost recovery, economists argue that opportunity and

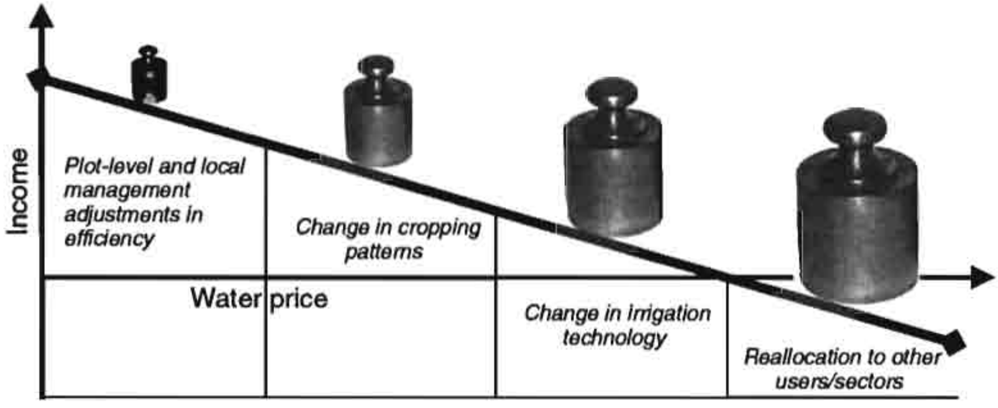

Fig. 2.4. Effects of water pricing as an economic tool.

externality costs are equally valid in societal terms (Rogers *et al.*, 1998; Tsur, 2004). Although their definition and estimation vary, the level of water charges may impact on farmer behaviour and bring economic benefits. Figure 2.4 proposes a tentative hierarchy of responses to increasing water prices, while recognizing that the order of these effects may sometimes be altered by relative factor prices and other aspects. Moderate water prices may trigger low-cost adjustments in water management, while higher prices may successively elicit changes in cropping patterns, in irrigation technology and, finally, release water to other higher-value activities. These effects imply a role for pricing as an economic tool and the likelihood of achieving such outcomes is examined in the following sections.

A Note on Terminology

A *water charge* can be defined as an actual (financial) payment by users to access water and is the term generally adopted in this chapter. It is equivalent to a *tariff*, a term commonly used in the domestic sector when differential rates are set. *Charge* is a term disliked by some decision makers, who fear that it suggests that water – perceived as a gift of nature or god – is taxed. In 1979, several Asian countries agreed to replace it with the term *irrigation service fee* (ISF) (ADB, 1986a). This is now often adopted, though it conflicts with the definition of a *fee* as an administrative payment (e.g. for the registration of a water right). Another term commonly used is *water price*. This is preferably confined to the (economic) price that emerges in a market as the result of the actions of willing buyers and willing sellers, with no connotation of (financial) cost recovery. Since such markets are rare in the water sector, *price* is often used as a synonym for *charge* to indicate the administrative rate set by an agency to a user. Most of the discussion in this chapter uses the term *water charge*, focusing on how water charges are reasoned, justified, determined, enforced, recovered and eventually expended.

A word is also necessary on the terms *ability-to-pay* and *willingness-to-pay*. Many studies conclude that farmers have an *ability-to-pay* much higher water charges than are charged in practice. This is sometimes supported by evidence that they are *willing-to-pay* much higher amounts for private irrigation and by the fact that consumers in the domestic sector are *willing-to-pay* much higher prices to street vendors than the tariffs charged by the utility. The use of these terms can, however, be confusing.

Willingness-to-pay is best used as an economic term to describe consumer behaviour. The poor may be *willing-to-pay* the high unit price charged by a private tube well owner or a vendor but buy little at this price, the amount being determined by profitability (in irrigation) or subsistence needs (in domestic use). As prices and incomes shift, demand also shifts reflecting the price, income and cross-price elasticities described by standard demand curves (Young, 1996). Similarly, private investments (such as wells) and their subsequent operation reflect investor assessment of profitability, that is, by farmers' *willingness-to-pay* (*or to invest*). Purchases from a private tube well owner or vendor and private investment in irrigation are determined in markets governed by the actions of willing buyers and willing sellers.[8]

If *willingness-to-pay* describes behaviour, *ability-to-pay* relates to farmer incomes and public subsidies. If irrigation investment is economically justified, and prices are undistorted, farmers should in principle be *willing-to-pay* all costs including capital cost. But irrigation is driven by non-economic objectives and in most cases farmers *should not* repay full capital costs. If they are unable to pay for marginal (future) costs, then – leaving aside distortions in other costs and prices – continued irrigation is itself uneconomic. In extreme cases, farmers may be unable to pay even recurrent costs since the resulting farm incomes are inadequate to sustain life (Cornish *et al.*, 2004) or the rainfed option is more profitable. But the issue in irrigation is seldom, if ever, an absolute inability-to-pay (although this may, of course, typify extreme cases in respect of domestic water). It is one of fairness, incentive and acceptability, and *ability-to-pay* is best thought of as that level of payment thought reasonable and practical, given the general context and government priorities and objectives. The level of subsidies given to construct a new scheme or sustain an existing scheme is thus ultimately a political decision.

[8]Such markets may, of course, be distorted as a result of monopoly practices, distorted input and output prices, changeable public policies, etc., and there may be a case for interventions by government or a regulator to correct for these distortions. They are also shaped by social relationships and values.

CHARGING FOR WATER IN PRACTICE

This section addresses the practicalities and modes of charging for water, as well as the current situation regarding cost recovery by irrigation schemes.

Main Types of Water Charge

The following are the most common ways of defining charges and their differentiation according to uses and users (Sampath, 1992; Tsur and Dinar, 1997; Garrido, 1999; Bosworth *et al.*, 2002; Easter and Liu, 2005):

1. *Uniform user charge* – users are taken to have similar access and are charged evenly. Even if the level of use varies, differences cannot, or are too costly to, be assessed.
2. *Area-based charge* – the irrigator is charged according to the area irrigated, based either on: (i) the area owned; or (ii) the area cropped (declared by the farmer or assessed by the agency).
3. *Crop-based charge* – the charge is based on area *and* type of crop. Differentials may be justified by crop priority (e.g. cereals for food security) or water diverted or consumed by crop or its value.
4. *Volumetric charge* – water is charged, based on actual diversions to a user or group of users (bulk water pricing). Metering is necessary but volume may be represented by time or the number of 'turns', provided discharges are more or less stable and predictable.
5. *Volumetric block tariffs* – when metered, charges can be fixed for different levels of consumption. Increasing block tariffs discourages excessive use. Decreasing block tariffs promotes sales and rewards economies of scale, being appropriate only if water is abundant.
6. *Mixed tariffs* – charges combine a flat rate (usually area-based) with a volumetric

charge. This provides both a stable minimum revenue to the operator and a variable charge according to use.
7. *Quotas at fixed charges* – quotas may be uniform (e.g. based on area) or vary by crop. Charges can be proportional to nominal volumes or vary with crop type (as in the Jordan valley).
8. *Quotas and marginal volumetric pricing* – users can access more than their quota (subject to availability and within limits), but additional use is charged at higher rates (as in Israel).
9. *Market-based price* – the price of water is determined in a market where allotments can be traded (within season, seasonally or permanently). If the market is regulated, the regulator may set the price, set price limits, serve as broker, etc. (as in the California Drought Bank).

Each method has its advantages and disadvantages, notably the ease with which charges can be calculated, justified and implemented. Additional modalities may also vary: for instance, charges may vary by season, be paid before or after cropping, in one or more instalments, in cash or in kind, etc.

Besides direct charges, farmers may also be charged implicitly via the tax system or in the level of output prices. Land taxes, for instance, often vary to reflect the higher productivity of irrigated land, and betterment levies may be imposed when irrigation is brought to an area for the first time. Similarly, procurement programmes and/or export duties can depress crop prices and can be thought of as an indirect charge. But this is not specific to irrigation and may be offset by other subsidies (e.g. on fertilizer). Moreover, farmers may be protected rather than taxed. These and related issues are thus best considered in relation to the general context rather than to irrigation charges per se (see earlier section).

Who Collects and Uses the Water Charge?

Water charges may be assessed and collected by the state, by a revenue or irrigation department, or by a combination of the two (as in much of India); by an autonomous irrigation entity at the national level (as in the case of the National Irrigation Administration (NIA) in the Philippines) or at the scheme level (as in China and other countries where schemes are managed autonomously or quasi-autonomously); or by a communal organization (such as a Water User Organization) collecting charges directly from its members. Numerous options exist. The state may assess and collect charges at farm level, and consider this levy as revenue. Alternatively, assessment and spending of this revenue can be shared with other levels. Again, a Water User Association (WUA) or some other agent may collect the fees and retain a pre-assigned share for its own requirements (e.g. O&M of the tertiary command), transferring the balance to the irrigation agency, the basin agency or the state, in return for irrigation supply. This can be paralleled by contractual arrangements made for bulk allocations and schedules at each level (e.g. between the river basin agency and irrigation entities, between the irrigation entity and pump/canal organizations and between the canal organization and the WUAs).

In other cases, a state or provincial government may regulate the different rates applied by various entities (including the charge paid by farmers), or each entity or organization may be free to establish its own rates subject to agreement between the different levels and approval under the rules of the organization. Where the state is responsible, payment may be reduced or forgiven in a drought or for some other reason.

There are also options relating to incentives and farmers' involvement in decision making. For instance, incentives may be provided to encourage collection either being paid to officials of the relevant organizations or to private subcontractors. The corresponding levels of farmers' involvement in decision making are equally important (e.g. in allocation decisions or possibility of hiring their own staff). The nature of the arrangements impacts on the rate of collection and on the potential for water conservation and enhanced water productivity, as discussed further below in the appropriate sections.

Who Pays What and How Much?

Types of charge

The most common form is area-based or area plus crop-based, as in Pakistan (Bazza and Ahmad, 2002), Nigeria (Olubode-Awosola *et al.*, 2006), Kazakhstan (Burger, 1998), Vietnam (Fontenelle *et al.*, Chapter 7, this volume), Turkey (Yercan, 2003), Argentina, Greece, Japan, Philippines and Sudan (Cornish *et al.*, 2004), with occasional distinctions by season (as in India, Saleth, 1997; or Nepal). This type of charge accounted for 60% of the sample studied by Bos and Wolters (1990).

Volumetric pricing is usual in the Middle East or North Africa, e.g. Tunisia (Hamdane, 2002a), Iran (Perry, 2001a,b), Jordan (Venot *et al.*, Chapter 10, this volume) and in countries such as the USA, Australia, Southern Europe and Mexico. Volumetric pricing is often associated with a quota, and defined at a bulk rather than at an individual level. Two-part tariffs are also common (e.g. Spain: Maestu, 2001; Colombia: Garcés-Restrepo, 2001; Lebanon: Richard, 2001; Morocco: Ait Kadi, 2002). Volumetric charges are widespread in lift irrigation given the ease of measurement (though not in Vietnam; see Fontenelle *et al.*, Chapter 7, this volume).

Numerous variations occur: in Indonesia charges may be differentiated by head, middle and tail, and be lower in unproductive areas (Hussain and Wijerathna, 2004), and in India they sometimes reflect water dependability (Sur and Umali-Deininger, 2003). In Bangladesh, at one time charges were set as 3% of gross incremental benefit but this proved impracticable (ADB, 1986b). In contrast, simpler approaches may be negated by considerations of equity: a flat per acre rate was, for instance, adopted in Sind in 1972 to reduce irregularities only to be abolished in 1980 since charges based on actual crop areas were thought fairer. Some countries once collected charges in kind (e.g. the Office du Niger, Mali: Aw and Diemer, 2005; Philippines: Oorthuizen, 2003), and in Tanzania this is still an option (Tarimo *et al.*, 1998). Elsewhere, rates are expressed in terms of a paddy quantity (e.g. in Vietnam and Philippines), though rates must be updated if productivity or prices vary (Carruthers *et al.*, 1985).

Some countries impose a resource charge in addition to an irrigation charge. This may simply be an administrative fee, e.g. for registering a water right, but can be a contribution to basin management costs South Africa (Spain, France: Berbel, Chapter 13, this volume; Tanzania: van Koppen *et al.*, Chapter 6, this volume; Colombia: Garcés-Restrepo, 2001). Resource charges are seldom significant to the farmer (e.g. 13% of O&M costs in Peru: Vos, 2002).

Despite occasional claims that models can assist in determining technically optimal prices (Tarimo *et al.*, 1998; Louw and Kassier, 2002; Garrido, 2005), there is little evidence that this has ever occurred: charges are invariably based on historical practice, microeconomic data on crop income or the level of O&M/investment costs (Lee, 2000) and are the result of negotiations or bureaucratic arbitration (Lanna, 2003). In general, a balance is struck between supply costs and what farmers can pay or, maybe more to the point, between tax collection costs and higher charges that would not be politically possible.

Charging mechanisms are not necessarily established once and for all and may evolve with circumstances and objectives (Rieu, 2005). Changes may be triggered by climatic circumstances (volumetric pricing will perform badly in dry years, as experienced in Mexico: Kloezen, 2002), level of state subsidies, O&M costs (which may vary with age of the system), type of incentives needed, etc. (see Plantey *et al.*, 1996; Nicol, 2001 for two French examples).

Rates of recovery

Collection problems have plagued many systems (World Bank, 2005c). Collection is low in Pakistan (30–60%: Bazza and Ahmad, 2002; less than 30% in Sindh: Cornish *et al.*, 2004; and 5–15% in schemes studied by Hussain and Wijerathna, 2004), Kenya (20% in West Kano: Onjala, 2001), Nepal (5%: World Bank, 1997), Bangladesh (less than 10%: World Bank, 2005c) and India (8% in 1989: Saleth, 1997), though 66% and 85% in Andhra Pradesh and Uttar Pradesh, respectively, in 1998 (Sur and Umali-Deininger, 2003).

Recovery rates tend to be higher: (i) under authoritarian governments; (ii) if supply is cut off for non-payment; (iii) if charges are low, recovered with other taxes and/or collected before the crop season; (iv) where users decide on the use of the charges; and (v) when supply is reliable. Thus, it is 98% in Mali (Office du Niger: Aw and Diemer, 2005), 95% in Turkey (Özlü, 2004), 90% in Syria (Bazza and Ahmad, 2002) and Tunisia (Hamdane, 2002a), 80% in Mexico (OECD, 2003) and the Jordan Valley (Venot *et al.*, Chapter 10, this volume) and 50% in Kyrgyzstan (Sehring, 2005). The overall rate of recovery for a sample of 82 irrigation providers was 77% (Lee, 2000).

Water charges come with both administrative and compliance costs that can be quite substantial (Nickum, 1998; Tiwari and Dinar, 2001; Johansson *et al.*, 2002) and differ depending on the type of charge (Tsur and Dinar, 1997). In Bihar, collection costs are said to sometimes exceed the income derived, being estimated at between 52% and 117% of the amount collected (Prasad and Rao, 1991). For Bhatia (1991), collection keeps '5,000 persons busy and unproductive in the fields'. Transaction costs make volumetric charging impractical in Egypt (Bowen and Young, 1986) and similar settings.

The burden of irrigation charges

This burden varies widely. Bos and Wolters (1990) reviewed 150 systems and, in all but one, water charges were less than 10% of the net farm income excluding water costs. The share ranges from zero if water is supplied free (as in Albania, Poland, Croatia: Cornish *et al.*, 2004, Saudi Arabia: Ahmad, 2000, Thailand: Molle, Chapter 5, this volume and Taiwan) to above 30% in pump schemes (e.g. 31% in Niger: Abernethy *et al.*, 2000; 34% in Gujarat: Cornish *et al.*, 2004; and even 65–76% in the Jordan highlands: Venot *et al.*, Chapter 10, this volume). Figure 2.5 shows the ratio for a number of schemes and scheme averages.

Two qualifications should be added here. First, formal charges do not capture in

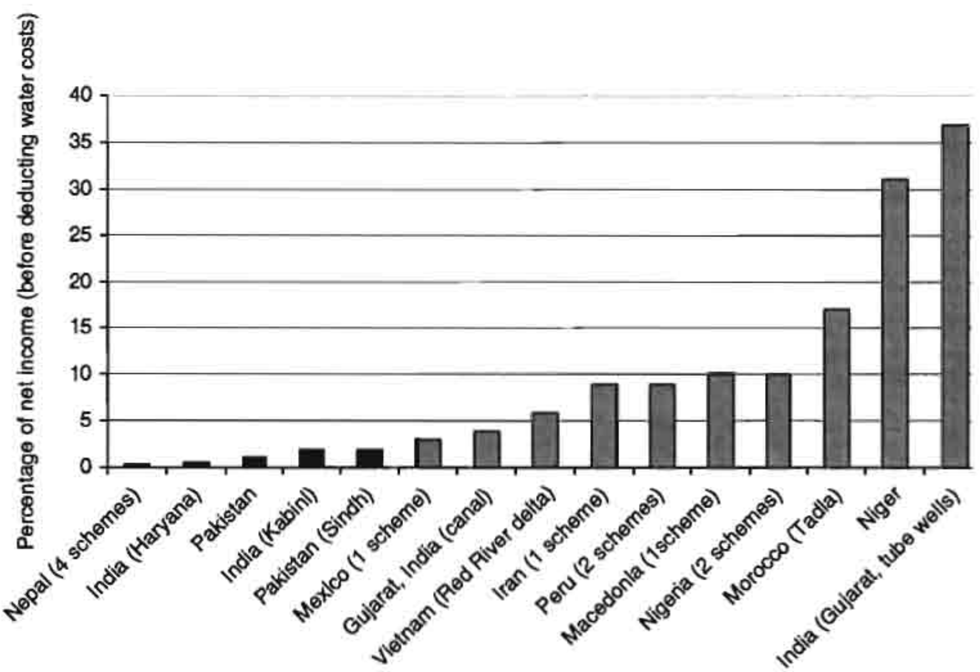

Fig. 2.5. Water costs as percentage of net income.

full the water payments made by farmers. Extralegal payments to local officials are widespread, especially if water is scarce (India: Wade, 1982; Indonesia: Rodgers and Hellegers, 2005; Vietnam: Fontenelle *et al.*, Chapter 7, this volume; Pakistan: Rinaudo, 2002). Farmers are also usually responsible for O&M costs within the tertiary – watercourse – command (in Egypt, India, Pakistan, Indonesia, etc.). Finally, farmers incur major on-farm costs including investments made to augment and/or offset insecurity in main system supplies (not only in private tube wells, but also in hand pumps, reuse systems, on-farm reservoirs, etc.). Second, averages disguise high variability. Low-yielding and tail-end farmers typically pay a higher proportion of net income in water charges (Carruthers *et al.*, 1985). Figure 2.6 shows, for a sample of 101 rice farmers in Sri Lanka studied by Hussain (2005), that water charges would greatly decrease income for the 25–30% of poorer farmers even if, on average, they are only 10–15% of the average net income (Rs 11,000/acre).

In some countries, charges are limited by law in terms of either a maximum share of net income or another measure (e.g. Vietnam); in Iran, regulated surface water charges are limited to 1–3% of the gross value of crop output (Keshavarz *et al.*, 2005); in Cyprus, the charge is limited to no more than 40% of the weighted average unit cost (65% in exceptional cases) (Tsiourtis, 2002); in India, a 1972 policy review recommended that water rates should lie within the range of 5–12% of gross farm revenue (Prasad and Rao, 1991; Vaidyanathan, 1992). Elsewhere, minimum values are sometimes (ineffectively) decreed as in Korea (Sarker and Itoh, 2001) and Peru (Vos, 2002). Block tariffs have been proposed to protect the poor though others conclude that water pricing mechanisms are ineffective in redistributing income, besides having perverse subsidy effects (Tsur and Dinar, 1995; Dinar *et al.*, 1997).

PRICING AS A FINANCIAL INSTRUMENT: COST RECOVERY

Arguments for Cost Recovery

Funds for physical sustainability

The least controversial – and most compelling – argument in favour of cost recovery in irrigation is to ensure the availability of funds needed to sustain physical sustainability of

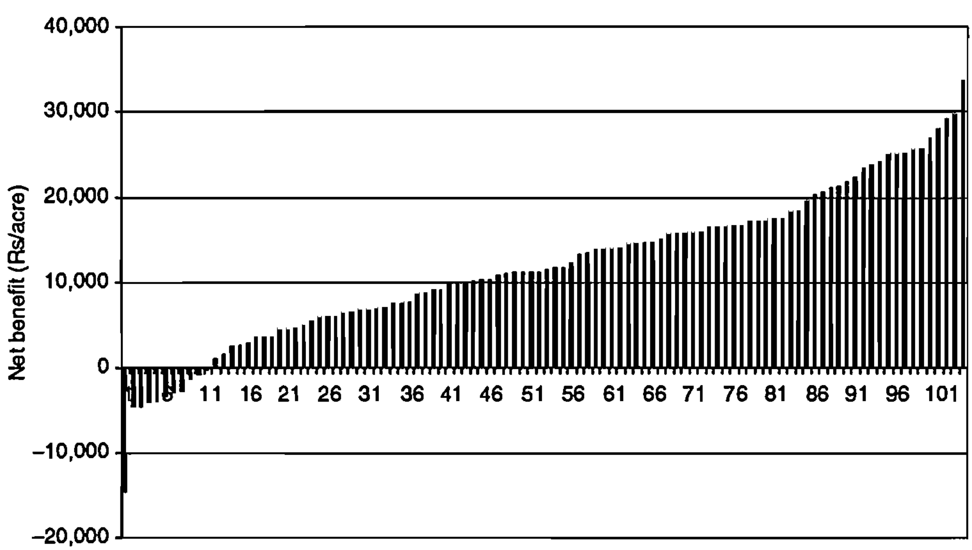

Fig. 2.6. Distribution of net income from rice cultivation (southern Sri Lanka).

the infrastructure. Concerns relating to physical sustainability have a long provenance, but rose to particular prominence in the 1980s when many governments and lending agencies faced the necessity of rehabilitating schemes that had sometimes been constructed only a few years back, but were already in a dilapidated state.[9] In Indonesia, for example, one-third of the 3 million ha of public sector irrigation schemes has been rehabilitated twice in the last 25 years (World Bank, 2005b). In the Philippines, successive projects funded by the World Bank and ADB have similarly returned repeatedly to the same national irrigation systems (World Bank, 1992) and, no doubt, other examples could be quoted. The decay of irrigation infrastructure leads to poor water delivery and is thought to lower agricultural production and decrease farmer income (Tiwari and Dinar, 2001; Hussain, 2005).

Degradation of facilities can be linked to many causes, including faulty design, shoddy construction, lack of incentives to respect covenants, pressures on public finances and a tendency by politicians to adopt a 'build-and-forget' approach to politically motivated projects. Widespread reliance on government for financing O&M has, in practice, led to underinvestment, deferred maintenance and degradation of facilities. This can also be related to 'public goods' and 'freerider' issues, as farmers intervene in low-level public infrastructure to secure their individual interests and as the incentives facing ill-paid operators and farmers have proved unsuited to the effective maintenance of both public and communal facilities. In many countries, tertiary maintenance is the responsibility of the farmers, yet even this is often poorly undertaken, in part due to the inability of the main system to guarantee predictable supplies, and in part due to lack of cooperation, freeriding and incentive issues at farmer level.

Underinvestment in maintenance is believed to be very considerable. For instance, total O&M requirements for public systems in India have been assessed at about Rs. 25–30 billion per year, yet less than a quarter of this amount is actually provided, with wide variation across states (Thakkar, 2000) and revenue receipts covering only 10% of expenditures in 2000 (Sur and Umali-Deininger, 2003). In Egypt, a desirable level of expenditures on O&M/rehabilitation has been put at US$234 million, yet only US$164 million is provided (Bazza and Ahmad, 2002). Comparable situations are found in numerous other countries, contributing to the perceived need for repeated rehabilitation as in Indonesia and the Philippines. The conclusion is that states have been de facto major defaulters and that sustainability depends on users taking over responsibility for maintenance.

Performance incentives

But paying for water does not by itself ensure good maintenance and service. When the receipt from water charges is channelled to state coffers, farmers come to regard charges as a tax rather than a direct benefit to themselves and pressurize politicians to reduce – even abolish – them. The assumption that paying for water in itself creates a sense of ownership has thus no doubt been overstated (e.g. Onjala, 2001, for Kenya).

[9] The literature provides uncontroversial evidence that these financial difficulties have been the driving force – or at least the chief justification – behind the revision of pricing policies, and also of many programmes of participatory irrigation management and varied degrees of turnover of management to farmer collectives (Frederiksen, 2005): see Burger, 1998 on Kazakhstan; Çakmak *et al.*, 2004 on Turkey; USAID, 2002 on Egypt; and Rap, 2004 on Mexico. Yet, the rhetorical argument that O&M costs are a 'huge drain' on state coffers appears frequently at fault. In 1997/98, canal irrigation subsidies were equivalent to 2.6% of the fiscal deficit in Karnataka and 7% of the fiscal deficit in Andhra Pradesh, with the same order of magnitude for Maharashtra, Rajasthan and Uttar Pradesh (Sur and Umali-Deininger, 2003). This seems significant, but only amounts to 0.1–0.3% of the respective state expenditures, a limited subsidy if redistribution to farming populations is considered a state policy (Molle, Chapter 5, this volume, and Venot *et al.*, Chapter 10, this volume, provide other examples for Thailand and Jordan).

When incentives are provided to the officials of the relevant organizations or to private subcontractors (these incentives may or may not be passed to users) to encourage collection or improve water management within the area they control, a link is established between payment and benefits to users. In order to close a virtuous circle of incentives, managers should ideally depend financially on farmers' contribution. Another fraction of the charges can be managed internally by a local group – e.g. farmers along a distributary or minor – for local repairs and maintenance or to pay ditch riders, thus ensuring that user payments are used to maintain the infrastructure and improve operations in direct sight of the farmers concerned. The focus here is not on paying benefit taxes to the state, but on ensuring both financial and physical sustainability through direct farmer involvement.

In sum, there are numerous variations of incentive mechanisms, depending on the degree of farmers' involvement in planning, allocation and hiring of staff, the level at which the boundaries are drawn between farmers' and agencies' responsibilities, and the inbuilt accountability mechanisms and incentives for financial contribution. Cost recovery makes full sense when arrangements are centred on financial autonomy, a clear definition of the responsibilities of managers and users and inbuilt accountability mechanisms (Small *et al.*, 1986; Small and Carruthers, 1991; Vaidyanathan, 1992; ICID, 2004; see Molle and Berkoff, Chapter 1, this volume, for a historical perspective). A reassessment of this model of financial autonomy will be attempted in a later section.

Equity considerations

Another important argument for recovering costs from farmers is that, having benefited from exceptional public investments, farmers should repay at least a part to the national budget on equity grounds (World Bank, 1984; Perry, 2001a,b). One mechanism for achieving this is a betterment levy (e.g. by increasing the land tax); another is by levying water charges. The equity argument is often supported by pointing to differences between investment in irrigated and rain-fed agriculture, and by the fact that water charges are seldom more than 5–15% of the incremental value of production relative to that of rain-fed output (Easter and Liu, 2005). Ministries of agriculture and irrigation typically spend much of their budget on irrigation (60% in the case of Thailand) and annual irrigation subsidies are often massive (Rosegrant, 1997; Sur and Umali-Deininger, 2003). Investment opportunities in rain-fed areas are no doubt more limited than in irrigated areas and it is perhaps understandable that governments start by developing regions that lend themselves to irrigation. Nevertheless, as argued earlier, irrigation subsidies have probably discriminated against the rain-fed farmer (ICID, 2004).

A related equity argument is that cost recovery can contribute funds for irrigation expansion in currently deprived regions, an argument notably employed by politicians in advocating investments in their constituencies[10] (World Bank, 1984) and by those who advocate irrigation as the driving force for regional development. However, if income from water charges or betterment levies is accrued to the general public budget, there is no assurance that it will be used to expand irrigation since Ministries of Finance typically allocate resources in line with general political priorities.

Objections to Cost Recovery

Identification of beneficiaries

At first sight, it is obvious that farmers are the beneficiaries of irrigation and the large majority welcome irrigation projects. Even so, they are neither consulted on construction nor are their obligations always clearly defined. Some may have to relinquish land while others may have invested earlier in private or communal

[10]This may unfortunately lead very often to uneconomic projects which are granted against political support to the ruling party, or to other MPs ('pork barrel' in the USA). A perverse outcome can be the 'overbuilding' of river basins (Molle, 2007).

irrigation and gain little by being included in the new scheme (e.g. in Iran, Thailand or Argentina). Demanding repayment of costs decided by the state in these cases seems inequitable. Moreover, irrigation is often provided in the context of multi-purpose projects and irrigation itself may benefit non-farmers (e.g. domestic users or those in the flood plain). Since cost allocation is seldom applied systematically, irrigators may be asked to pay more than a fair share of joint costs (though hydropower rather than irrigation is more typically overcharged). Moreover, as argued earlier, if much irrigation is underpinned by strategic objectives and is inherently uneconomic, recovery of full costs is neither fair nor practicable: 'Is it fair to charge the full cost (including the capital cost) for projects designed without the farmers' say or designed on the basis of higher world grain prices?' (ICID, 2004).

Cost recovery is sometimes taken to imply that all costs should be recouped from direct beneficiaries. However, some argue that the 'joint private/public nature of benefits that result from such projects' and the long-term nature of economic returns may warrant subsidization by the state (Kulshreshtha, 2002). Others assert that irrigation facilities are a form of social overhead capital with farmers being just one category of beneficiaries amongst many (Small, 1996). If so, it is arguable that other beneficiaries – traders, processors and transporters – should be charged a share or irrigation costs. More broadly, a whole region may benefit from the stimulus of irrigation and consumers everywhere benefit from rising farm output in the form of lower prices (Sampath, 1992; Small, 1996; Bhattarai *et al.*, 2003). Thus, it is sometimes argued that 'indirect beneficiaries of irrigation, (notably) consumers of cheap food, should be happy to subsidize irrigation development through taxes' (Perry, 2001a,b).

Care must be taken in disentangling these arguments. If multiplier benefits are limited to *incremental* impacts relative to those of the alternative project (which also, invariably, exhibit such multiplier effects), then – for this and other reasons – the conditions under which they can be included in total benefits are restrictive (see first section). Moreover, food marketing is often amongst the most competitive sectors in developing countries. If so, participants, by definition, pay almost full economic costs so that charging specific indirect beneficiaries for a share in irrigation costs risks double-counting. The justification given for indirect benefits is thus less convincing than sometimes implied.

As Abu-Zeid (2001) recognizes, governments may 'continue to subsidize [new] projects for several reasons, e.g. enhancing national security, maintaining political stability, decreasing population density in certain sensitive geographical regions and conserving water'. Given these national objectives, the level of capital cost recovery that is desirable is ultimately a political judgement given the context concerned, reflecting judgements on the weights given by society to national objectives other than economic optimization.

Cost estimation

Cost estimation – and hence the level of cost recovery implied – is seldom straightforward. For schemes constructed in part with unpaid labour (whether voluntary or otherwise) – as in China, Vietnam, Burma and at the tertiary level in many countries – implicit farmer contributions should be excluded. FAO and USAID (1986) have also suggested that 'farmers should not be asked to repay the cost of over-elaborate gold-plated designs, incompetent, expensive construction, costs overruns for reasons of corruption, bad scheduling of construction activities or the like'. Similarly, farmers should not be asked to pay for overstaffing,[11] poor management and corruption (Rao, 1984; FAO and USAID, 1986; Bhatia, 1991; Gulati and Narayanan, 2002 – Rao has estimated that in India only about half of officially estimated costs represent real costs). Moreover, with regard to maintenance, should actual costs or ideal costs be

[11] Lee's (2000) review of 82 irrigation providers found an average of 38% of O&M costs spent on salaries, with a maximum of 82%; it is 80% in Sindh, Pakistan (SIDA, 2003), but only 10% in northern Vietnam (see Fontenelle *et al.*, Chapter 7, this volume).

considered and how should the ideal be defined? Systematic maintenance may lengthen a project's life, but what is the economic optimum? Finally, convincing farmers that opportunity and externality costs are real, let alone charging them for these costs, is extraordinarily difficult (see later section).

Irrespective of whether actual O&M and related costs are justified, they must be financed either by government or by farmers if irrigation is to be sustained. As noted earlier, scheme autonomy strengthens incentives for containing costs to those justified by prevailing conditions. In the state of Victoria, Australia, for example, when farmers were required to pay the full costs of O&M, increased scrutiny of the supply agency led to a 40% reduction (World Bank, 2003a,b). While farmers tend to take a short-term view of what is required, often in the hope that government will, in due course, rehabilitate the scheme, they also usually have a much better idea than unaccountable public agencies of what is truly required (sometimes less than external experts commonly suppose).

Cost Recovery: Empirical Evidence

The literature suggests that no more than a portion of O&M costs is typically recovered (Dinar and Subramanian, 1997; Cornish *et al.*, 2004; Easter and Liu, 2005), a conclusion that probably holds despite inconsistencies in the definition of these costs. OECD countries often recover full O&M costs (Garrido, 2002; Berbel *et al.* Chapter 13, this volume), while Latin America (notably after management transfer) and the Mediterranean basin (e.g. southern Europe, Tunisia, and Morocco) have fared better than Asia and Africa, and East Asia better than South Asia (ESCWA, 1999 for Western Asia; Ringler *et al.*, 2000 for Latin America; Chohin-Kuper *et al.*, 2002 and Bazza and Ahmad, 2002 for Mediterranean countries; Cornish *et al.*, 2004 for a review). Figure 2.7

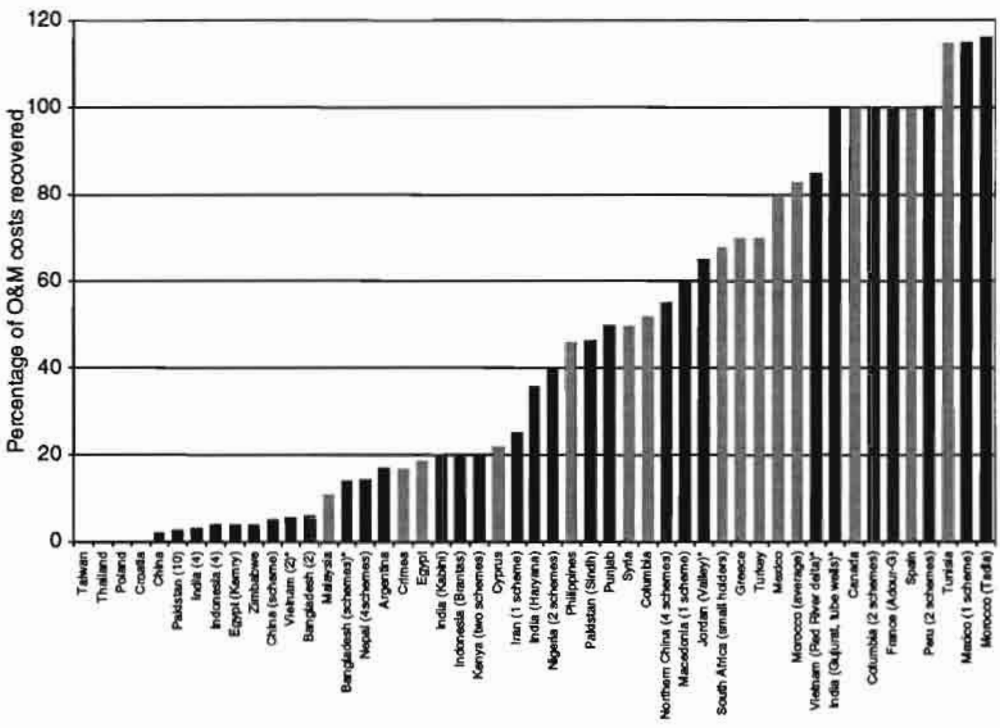

Fig. 2.7. Water charges relative to O&M costs in selected schemes and countries.

plots average levels of cost recovery for a number of cases, distinguishing between particular schemes (both gravity and pressurized marked with*) and country averages (in grey).

Beyond these average estimates drawn from the literature, in practice both O&M costs and cost recovery levels vary over time depending on water use patterns and the age of systems, government policies and organizational arrangements (Carruthers *et al.*, 1985). For instance, the real irrigation charge in Tunisia was raised by 2.4 times between 1990 and 2000 and collections rose from 57% to 90% so that they now cover, on average, 115% of O&M costs (Hamdane, 2002a,b). In Morocco, charges in the Tadla scheme cover both O&M and depreciation (Hellegers *et al.*, Chapter 11, this volume), although they cover no more than O&M costs in three other gravity schemes, and 66% in three major pumping schemes (values for 2001; Belghiti, 2005b).

Historical evidence suggests that in no country have the beneficiaries shouldered a significant share of the initial capital costs of large-scale irrigation, let alone the costs of subsequent irrigation expansion. Many schemes date back to when irrigation expansion was a national policy and are targeted for cost recovery mainly to contain current public expenditures. Even in richer countries, it is difficult to justify the recovery of capital costs of past public projects, given that irrigation benefits have usually been capitalized in land values and, given that relative price shifts often make it financially impossible (see Pigram, 1999 on Australia; Musgrave, 1997). Postel (1992), for instance, reports that 4 million ha in the west USA are supplied 'at greatly subsidized prices' by the Federal Bureau of Reclamation (see also Anderson and Snyder, 1997), reflecting the fact that the 1902 legislation emphasized western settlement rather than full market returns for Federal water projects (Gollehon *et al.*, 2003). Irrigators in the Central Valley Project have repaid only 4% of the capital cost. Currently, repayment of capital costs averages about 15% in real terms (Howe, 2003; Hanemann, 2006).

In South Korea, financially autonomous Farmland Improvement Associations (FLIAs) have repaid part of initial capital costs, in addition to shouldering full O&M costs (ADB, 1986b) and in Japan corporate Land Improvement Districts shoulder 10–15% of the costs of large-scale state irrigation projects and 25% of medium-scale projects initiated by prefecture governments (Sarker and Itoh, 2001).[12] The principle of capital cost recovery has been incorporated in European directives and has the clear potential to ensure that projects are cost-effective and to crowd off marginal and politically motivated water resource development (Garrido, 2002). Yet, perhaps for this very reason, obstacles still prove pervasive and fiscal discipline elusive (Hill *et al.*, 2003).

Morocco is a rare example in the developing world in having an Agricultural Investment Code that specifies 'with the objective to alleviate the [financial] burden on farmers, (irrigation rates) will be called upon to contribute to investment costs *only* to the level of 40% of these costs' (Belghiti, 2005a; emphasis added). Although this level has yet to be attained Morocco has taken bold steps towards financial autonomy. In Egypt, new irrigation areas (New Lands) for commercial entrepreneurs are also being granted with a degree of cost sharing (Perry, 1996), while expansion of the irrigated area in the Office du Niger (Mali) included 20% of contribution by farmers (Aw and Diemer, 2005). In contrast, in Bihar and Haryana, where irrigation remains firmly in the public sector, if capital costs were charged in full, payments would amount to 40–90% of net incremental farm income (Bhatia, 1991).

Development agencies have long been reluctant to recognize that few countries will recover more than a nominal share of initial costs, and that irrigators' 'debt' to the state will be eventually written off, even in developed countries (Garrido, 2002). For example, ADB's 1985 review (ADB, 1986a) calls for 'benefit-conscious project preparation' and notes that the disregard for loan covenants

[12]It is perhaps no coincidence that South Korea and Japan simultaneously subsidize their rice-farming sector through import duties and controls that lead to very high internal prices and promote domestic production.

(in particular on ISFs) by governments is not being addressed. Pitman (2002) observes that 'Globally, most [World] Bank projects pay lip-service to (capital cost) cost recovery', but that those which addressed this issue in practice were largely water supply projects. Recognition of the case against full capital cost in irrigation and greater realism in practice would clearly be desirable (World Bank, 2003a,b).

Empirical evidence also shows that very seldom are incentives linked to charges. Bos and Wolters' (1990) survey of 159 schemes covering 8 million ha showed that there is no relation whatsoever between the level of charge and efficiency. This was confirmed by later findings by Jones (1995) which showed that revenue from water charges generally goes to the general treasury and is not earmarked for O&M. A typical example is Pakistan where revenues from water charges go to the provincial or state treasury, losing the link between payment and O&M and quality of service (Bazza and Ahmad, 2002) (see also Jordan: Venot *et al.*, Chapter 10, this volume; and India: Samal and Kolanu, 2004). Conversely, the failure to ensure reliable supply is one of the major reasons for widespread defaulting (Carruthers *et al.*, 1985; ADB, 1995; Spencer and Subramanian, 1997). Samal and Kolanu (2004) note the 'categorical and explicit refusal of [Indian] farmers to pay the water tax till the irrigation service was improved'. In Sindh, Pakistan, 'farmers are not willing to pay since the financial system is not transparent and they do not see that the charges paid are used to deliver a good service'. The farmers said that they were willing to pay for services, but not for 'someone's wife's jewellery' (Cornish and Perry, 2003).

Even where progress has been made in transferring responsibilities at the tertiary or secondary level to farmer organizations under irrigation transfer and similar programmes, supply has often remained unpredictable. Whether due to suboptimal management, to real constraints in controlling stochastic water variability and uncertainty or to what happens upstream, insecure main system supplies have undermined efforts by farmers to organize at secondary or block level. For example, Parthasarathy (1999) has shown that, in Gujarat, India, WUA members failed to pay higher rates when they appreciated that managing an isolated or terminal portion of the canal system failed to contribute to any real improvement in the reliability of water supplies. As Freeman and Lowdermilk (1991) put it: 'To disconnect farmer payments of assessment for maintenance, whether in cash or kind, from water delivery is virtually to invite organizational decay.'[13]

In most countries, governments continue to be responsible for the funding of main-system O&M, together with replacement, rehabilitation and modernization works, quite independently of charge collection itself. In other countries, notably in East Asia, Latin America and much of North Africa (as well as in most developed countries), irrigation water charges are collected and retained by scheme management (irrigation district). But even in these situations, O&M expenditures can be deficient. In China or Vietnam, for instance, the level of water charges is regulated by national, provincial and local price commissions, and, though in principle authorized charges are based on estimated requirements, in practice increases have been limited with a view to reducing burdens on farmers (Hydrosult, 1999; Lohmar *et al.*, Chapter 12, this volume). Similarly, the Government of the Philippines has repeatedly failed to authorize the NIA to effectuate needed increases in water charges (World Bank, 1992). Financial autonomy – total or partial – has been practised widely in developed countries,

[13]In addition to farmers' reluctance to contribute, low rates of recovery are compounded by agencies' reluctance to enforce collection (Carruthers *et al.*, 1985), due to drudgery avoidance, unwillingness to antagonize farmers and desire to keep good relations, sympathy for their economic situation, or fear to give farmers reasons to question the quality of service.

including the USA, Spain, France, Italy, Mexico, Japan and Korea.[14]

PRICING AS AN ECONOMIC INSTRUMENT: WATER CONSERVATION

Introduction

That water is wasted due to underpricing is a widely held view, from the former President of the World Bank ('the biggest problem with water is the waste of water through lack of charging': Wolfensohn, 2000) to the World Water Vision ('users do not value water provided free or almost free and so waste it': Cosgrove and Rijsberman, 2000), to detached analysts ('water is consistently undervalued, and as a result is chronically overused': Postel, 1992) and environmentalists who favour 'developing a pricing system that prevents excessive use of water' (WWF, 2002). For the EU (2000b): '[E]fficient water pricing policies have a demonstrable impact on the water demand of different uses. As a result of changes in water demand, efficient water pricing reduces the pressure on water resources. This is particularly true for the agricultural sector.'[15]

Seemingly corroborating the assumption of waste is the fact that irrigation accounts for approximately 70% of withdrawals on average. Agriculture 'gobbles up at least 75% and sometimes as much as 90% of the available water', while 60% of water deliveries fail to reach the fields (The Economist, 2003). Profligacy combined with agriculture's dominant share suggests an easy solution: if raising irrigation charges can reduce losses even by a small percentage, sufficient water can be freed to meet the much smaller demands of other expanding sectors (World Bank, 1993; Winpenny, 1997; Gleick, 2001; Louw and Kassier, 2002; Davis and Hirji, 2003; IRN, 2003).

This section evaluates whether low water charges lead to waste and higher charges promote conservation. It first examines the received wisdom that 'water is wasted because it is underpriced'. Then it examines the conditions under which pricing water can be a 'key to saving water' and assesses the empirical evidence. It concludes by evaluating the potential of pricing for promoting conservation.

Is Water Wasted Because It Is Underpriced?

Is water wasted?

The first section showed that the concept of irrigation efficiency is often misstated. If water is abundant – in surplus basins, or during the rainy season, after it rains – excess diversions matter little since they return to the hydrological cycle (though, of course, they can impact adversely on water control, waterlogging and flooding). If water is scarce, farmers compete for the limited flows available: the struggle for water *when it is scarce* means that little water is wasted *when it has value*, and this is shown by observation of shortage situations. Moreover, losses may be used – after a delay – downstream or from aquifer recharge and only if water flows to the sea or another terminal sink is it no longer available for human use.[16] The central issue is thus one of *basin* efficiency and focusing on farm-level or scheme efficiency can be very misleading.

[14] Although this autonomy is partly paralleled with, or allowed by, massive subsidies granted through output prices or direct payments.

[15] See also 'Inefficient pricing and management of irrigation water supply leads to massive wastage' (Hansen and Bhatia, 2004) and similar statements in Holden and Thobani (1996), FAO (1998), ESCWA (1997), UNESCAP (1996), Ringler *et al.* (2002), TDRI (1990), Siamwalla and Roche (2001), Roth (2001), Bate (2002), etc.

[16] Flows to the sea may still, of course, have important environmental functions, including: flushing out sediments, diluting polluted water, controlling salinity intrusion and assuring the sustainability of estuary and coastal ecosystems.

There might be cases of a water-abundant scheme located within a water-short basin. Such a situation may be due to locational reasons, specific water rights or political influence that insulates that particular scheme from overall scarcity. This is a problem of (basin-wide) allocation and equity, which has other roots and will not be solved by pricing policies.

Is wastage due to low prices?

The above explanation implies that much less water is 'wasted' than is commonly supposed. Residual 'real' losses (evaporation from open surfaces, transpiration via unproductive growth, etc.) may be identified on a case-by-case basis but can 'real' losses be attributed to low water prices? A first issue is that shifts in farmer behaviour (induced by prices or otherwise) only impact on the share of diversions they receive. Ray (Chapter 4, this volume), for instance, estimates that farmers in the Mula scheme receive no more than 30–35% of the water released from the reservoir, the remainder being 'lost' from the canal system. Typical losses of 50% imply that raising the water charge to farmers can at best impact on about one-half of the water diverted. A second issue is that scheme-level deficiencies primarily relate to inequities (head-end and tail-end problems) and socio-economic costs rather than physical losses. Whenever wastage (or shortage) occurs, it is because the supply made available at the farm inlet is not in line with needs, and the causes of this mismatch remain largely independent of the users themselves (Grimble, 1999; Rodgers and Hellegers, 2005). Resolving such problems is primarily an issue in design and management, and remedies lie at the system level rather than with changing the behaviour of farmers (Chambers, 1988): effective control of supply is needed but, as Small (1987) aptly observed: '[I]t is likely that once this prerequisite exists, the amount of "wastage" will be greatly reduced, thus lowering the potential efficiency gains from any subsequent attempt to introduce water pricing.'

Conditions for Water Pricing to Elicit Water Savings

Although the causal relationships between low water-use efficiency and low prices are weak, and the fundamental objective is to optimize agricultural returns rather than minimize physical losses for their own sake, there is nevertheless a case for adopting pricing policies whenever they can contribute to this fundamental objective. Although the opportunities may be very limited, there is a continuum from conditions where price has no impact on water use and solutions lie entirely in management, to conditions where water is on demand and farmers can adjust volumes to reflect marginal returns (Fig. 2.3). This subsection addresses the prerequisites for the latter (see also Ray, Chapter 4, this volume). Associated issues related to externality and third-party impacts are considered in a later section.

Is pricing volumetric?

It is sometimes argued that, by making farmers aware of the value of water, even a flat rate promotes water savings (for Tanzania, see van Koppen *et al.*, Chapter 6, this volume). But there is little evidence for this: on the contrary, farmers try 'to get as much as possible of the thing for which they have been taxed' (Moore, 1989; Bos and Wolters, 1990; Berbel and Gomez-Limón, 2000).

Pricing can thus conserve water only if supply is volumetric. Problems of volumetric measurement are well known (Moore, 1989; Sampath, 1992; Rosegrant and Cline, 2002). For historical, technical, financial and managerial reasons, measurement at farm level is rare and even then charges may not be based on measured volumes. In some cases (e.g. for paddy), measurement at the farm level is unworkable without major structural investment (Moore, 1989) and installing functional devices in flat gravity systems (e.g. in deltas) is impracticable. More generally, measurement at the farm level is prohibitively expensive in surface systems with thousands, if not hundreds of thousands, of small farms. Tampering is pervasive and the transaction costs of data collection, monitoring and enforcement are beyond the capacity of most agencies and control at farm level is an illusion: Cornish *et al.* (2004) conclude that 'in practice, volumetric methods of supply to individual farmers are probably not feasible in large parts of the developing world at present'.

Charging for bulk allocations – to a WUA, distributary organization or other scheme entity – is a way to circumvent the transaction costs of charging for individual supply (Carruthers *et al.*, 1985; Repetto, 1986; World Bank, 1986; Asad *et al.*, 1999) and is needed in any case for effective (volumetric) management. But, if bulk charges are to impact on water use, contractual or quasi-contractual agreements must be enforced (Fig. 2.3) which requires more than reforms based on little more than wishful thinking, as noted earlier. While enforcement and collection delegated down the system, closer to the farmer tends to promote participation and accountability, the critical point is to pass incentives on to farmers.

Is water demand elastic?

A second obstacle to effective conservation pricing is that the elasticity of demand for irrigation water at current charges is low or negligible (de Fraiture and Perry, Chapter 3, this volume). Bos and Wolters (1990) found that in all but one of the projects studied charges were less than 10% of net farm income and 'too low to have significant impact'. Latinopoulos (2005) found no relationship between charges and water use in a sample of 21 irrigation districts in Greece, and a study of nine Spanish schemes attributed differences in water use to other factors (soils, nature and abundance of the source, history, etc.), concluding that inelastic demand reflected the relatively low share of water in production costs and the lack of a substitute (Carles *et al.*, 1999). Some studies carried out in the USA indicate a similar lack of responsiveness to price (Hoyt, 1982; Moore *et al.*, 1994). Volumetric pricing is most often associated with pressurized systems and high-value crops, the very situations where efficiency is already high and water costs (hence elasticity) marginal (Albiac *et al.*, 2006).

That volumetric charges seldom impact significantly on farmer behaviour (Gibbons, 1986; Malla and Gopalakrishnan, 1995; Bosworth *et al.*, 2002; Rosegrant and Cai, 2002) is perhaps hardly surprising given that irrigation water is a subsidized intermediate input. There is probably always a range over which demand is elastic, with elasticity rising as charges approach full cost. However, such charge levels have been shown earlier to be unrealistic in uneconomic schemes where water is subsidized. At current levels, even large increases make little impact since other costs are relatively more important, and cross-elasticities determine water use. Water prices in Iran, for instance, would need to rise by a factor of 10 to be effective in curtailing demand (Perry, 2001). Given the political sensitivity of pricing issues governments cannot be expected to risk raising charges well above O&M costs, just for the sake of encountering elasticity.[17]

In contrast to inelastic demand at farmer level, autonomous irrigation entities should, in theory, behave like profit-maximizing industries and reduce use in response to all bulk charges. In developed countries, regulators require irrigation districts to cover costs but even then they often skimp on O&M and/or seek other income sources to avoid 'bankruptcy'. In developing countries, farmer resistance to enhanced charges is stronger, whether the system is managed by government agencies, canal organizations or WUAs. Evidence from China and elsewhere

[17]Although this is advocated by Brooks (1997): 'Most would argue that . . . water tariffs should be designed to encourage conservation, not just to recover costs (which implies that pricing should be high enough to move into the elastic portion of the demand curve).'

(see below) suggests that institutional reforms can strengthen main-system management and transfer costs to autonomous entities, but there are still few examples where bulk water charges as such have led to significant water savings.

Lastly, true elasticity of response is very hard to establish because there is so little information on the relationship between improving efficiency at the farm level and the costs of doing so for a given irrigation technology and a given pattern of supply (see de Fraiture and Perry, Chapter 3, this volume). All shifts involve costs, e.g. in increased drudgery, labour or capital, and depend, *inter alia*, on farmer strategies and on the opportunity cost of their labour[18] (Venot *et al.*, Chapter 10, this volume); but estimating such costs and the associated responses is complex. Modelling exercises almost invariably oversimplify and focus on induced changes in terms of crop mix or technology without recognizing all the costs involved. As a result, the estimates of elasticities tend to be crude and unconvincing (more on this later).

Water Pricing and Water Savings: Empirical Evidence

Dinar and Subramanian's (1997) cross-country review showed that water prices across countries are not related to relative water availability, suggesting either that the current objective for charging is not to manage scarcity, or that other factors come into play. That countries with higher scarcity are not 'more aggressive in reforming pricing schemes' also brings out that other mechanisms are preferred. This was confirmed by a 2000 review of the last 67 irrigation projects funded by the World Bank, which revealed that in none of the projects had water charging mechanisms been planned as incentive tools (Tiwari and Dinar, 2001). Since, in any case, relations between water use and prices can only be expected under conditions of volumetric management, we focus here on cases of bulk allocation and individual volumetric pricing.

Bulk allocation

Sri Lanka, Turkey, China and Mexico are amongst countries that have promoted bulk allocation and in some cases have also introduced charges for bulk supplies:

- Evidence from Mahaweli System H in Sri Lanka showed that allocation at block level can lead to lower diversions, but this is primarily due to stricter scheduling and improved main-system management, resulting in more predictable and uniform flows and reduced conflicts. Water charges are not differentiated at farm level, and though WUAs are charged in proportion to water allocations, charges are not based on volumetric measurement and are too low to provide incentives for water savings (IWMI, 2004).
- Similarly, in Turkey, major irrigation has largely been transferred to irrigation districts that receive bulk water at no cost though they are expected to meet O&M costs in their own area. Reliability of supply has improved and fee recovery has increased substantially (Yercan, 2003; Özlü, 2004), the transfer of the financial burden of O&M to farmers being the main objective of the programme (Ünver and Gupta, 2003). But flat-rate charges have no impact on water conservation at farm level and tertiary distribution remains deficient (Yercan, 2003).
- The transfer programme in Mexico goes a step further (Kloezen, 2002). The

[18]Such interventions include avoiding breaches in bunds or continuous irrigation (for rice farmers), fine-tuning cut-off time to avoid losses at the end of furrows or not using sprinklers on windy days. Other adjustments relate to changing cropping techniques, like resorting to rice dry-seeding (e.g. in the Muda scheme, Malaysia: Guerra *et al.*, 1998), using mulch in vegetable plots or reducing the length of furrows. Other responses are more capital-intensive, such as laser land-levelling, which allow reduced and more homogeneous application of water by gravity, and frequent renewal of drippers in micro-irrigation.

National Water Commission in consultation with user representatives determines allocations to Irrigation Districts on an annual or seasonal basis. Bulk charges are met out of an O&M charge assessed and collected by WUAs and passed to the Commission via the District. Although O&M charges are levied in proportion to the amount contacted to the farmer by the WUA, they remain fairly low (2–7% of gross product in the scheme studied by Kloezen) and reflect O&M costs rather than conservation objectives. Seasonal quotas are tradable amongst WUAs within a district, with trades usually triggered when a WUA cannot meet the contractual demands of their members (Kloezen and Garcés-Restrepo, 1998). Maintenance is often suboptimal, with many WUAs unwilling to incur major costs and raising revenues only as immediate needs arise (Pérez Prado, 2003).

- Lessons from China are masked by the diversity of physical and institutional settings (Lohmar *et al.*, Chapter 12, this volume). Water is usually delivered in bulk by basin and system organizations to township or village entities, WUAs and even private operators. Bulk water charges in some cases have contributed to reduced diversions as entities at each level seek cost savings. Generally, however, even if bulk water supplies are priced volumetrically, current pricing policies rarely effectively encourage water saving at farm level (see Fontenelle *et al.*, Chapter 7, this volume), in part because farmers may be unaware of how water charges relate to other rural charges. Farm quotas necessarily decline when diversions decline but the reform process still appears strongly government-controlled (Mollinga *et al.*, 2005).

These examples confirm that bulk allocation is primarily a mechanism for: (i) improving the predictability and reliability of deliveries at basin and main canal levels; and (ii) allowing partial financial and managerial autonomy to WUAs, thus shifting part of the O&M costs to them. Bulk water pricing can generate revenue, but even if farmer charges are assessed in relation to delivered quantities, they are seldom charged on a volumetric basis; and even if charged volumetrically, they are seldom high enough to promote conservation (Asad *et al.*, 1999; Tiwari and Dinar, 2001). Internal trading (as in Mexico) can improve scheme-level efficiency but, of the examples quoted, only in China is there evidence that some scheme managers have a clear incentive to reduce bulk diversions (Lohmar *et al.*, Chapter 12, this volume).

Individual Quotas and Irrigation on Demand

Technical control may allow volumetric monitoring at farm level, but only if water is supplied on demand can the full potential of water pricing be realized. There is a continuum from individual quotas to irrigation fully on-demand, depending on how constraining quotas are and how responsive the system is to user requests:

- In Morocco, farmers pay a minimum fee equivalent to 3000 m^3/ha (Ait Kadi, 2002). In most cases, water is distributed by rotation and farmers must pay the full amount. In practice, quotas are low and any savings would depend in effect on the adoption of micro-irrigation. The water charge is based primarily on cost recovery rather than on conservation criteria, though in pump schemes the water bill can be up to 65–70% of gross income (e.g. Souss Massa groundwater: Ait Kadi, 2002) and in these cases it undoubtedly influences farmer behaviour.
- In Jordan, quotas in the valley are assessed at individual level and based on crop type, thus promoting water savings (Venot *et al.*, Chapter 10, this volume). Despite pressurized systems over most of the area, water variability and canal capacity preclude arranged demand irrigation and water is rotated at block level. Charges are set in relation

to O&M costs rather than to regulate use, though higher charges may prompt crop shifts and raise water productivity. The (coming) Wahda dam (Courcier *et al.*, 2005) and on-farm reservoirs help offset the rigidities of rotational delivery.

- European countries – Italy, France, Spain – also provide examples of modern pressurized irrigation systems that handle scarcity in the first instance by quotas (which may be very low, e.g. 2000 m^3/ha in Capitanata (South Italy), Genil Cabral (Spain) and the Neste system (France)).[19] There is usually flexibility at the margin with the above quota-use penalized at rates as high as 10 times the variable component in Charentes in France, and 25 times unit cost in Genil Cabral (Maestu, 2001; Montginoul and Rieu, 2001). Water distribution is usually by 'arranged demand' rather than under direct farmer control, and rotational delivery is often required at peak periods or during droughts.
- In Israel, the small unified distribution system is almost fully reticulated and pressurized, and backed by storage in the Sea of Galilee and managed aquifers. In contrast to systems of 'arranged demand', cooperatives and farmers retain discretion over when to irrigate under normal conditions. However, they are subject to cooperative and/or individual quotas that are charged at rising block rates. This has contributed to regulating water demand at the margin (Kislev, 2001) so that average use has sometimes been below the quota. Quotas in principle are adjusted annually but, in practice, they are regarded as water rights (Plaut, 2000; Kislev, 2001).
- A system that comes close to fully on-demand is that operated by the Canal de Provence in France, where the main canal is dynamically regulated to meet agricultural and municipal demands. No formal quotas are announced and farmers are free to irrigate as they wish (although they have to subscribe to a given delivery discharge). Prices are set to recover costs rather than to control demand, but the price structure is complex (Jean, 1999), distinguishing differing periods and between peak and normal demand, and it can be assumed that there are some incentives for water savings.
- Other cases include California, Canada, Peru and China. During the 1990–1994 drought in California, Broadview's water supply had to be decreased by more than 50%. Instead of raising prices in order to reduce demand accordingly, it was found preferable 'to begin allocating water among individual farmers' proportionally to the size of their farms, while providing cheap loans to encourage farmers to purchase sprinklers and gated pipe irrigation systems (Wichelns, 2003). In one system of northern Peru studied by Vos (2002), pricing was volumetric but was not used to manage scarcity: rather in times of shortages the rules employed promoted equity and defined quotas that limited use. In Shangdong, China, the use of integrated circuit (IC) machines ensures that farmers cannot obtain irrigation water without paying (Easter and Liu, 2005) and seems to provide reliable on-demand water.
- In some countries (e.g. in western states of the USA, Chile, etc.) quotas are defined as individual rights and a legal framework has been developed for trading these rights. Management continues to be determined by quotas and water distribution is still, usually, by 'arranged demand'. However, water trading redistributes quotas and contributes to higher economic returns. System constraints, third-party concerns and regulatory aspects may confine trades to neighbouring farmers, with little impact on irrigation water use, but in some places water is traded out of agriculture (e.g. the Colorado-Big-Thompson scheme).

[19]See Mastrorilli *et al.* (1997), Altieri (2001), Berbel *et al.* (2001), Hurand (2001) and Maestu (2001).

Public and communal groundwater suffers many of the same constraints as surface irrigation. A study of collective wells in Mexico – which modelled crop and irrigation options – showed, for instance, that a 30% reduction in groundwater use would require water charges to be (unrealistically) raised by a factor of 4 (Jourdain, 2004). In contrast, private groundwater approximates to irrigation on demand. So long as groundwater is abundant and input and output markets remain undistorted, extractions are determined by costs or prices and the results can approximate to an economic out-turn. But, in contrast to surface systems subject to supply constraints and quotas, in the absence of these preconditions groundwater regulation is seldom feasible since the transaction costs usually prove insurmountable, given the number and dispersal of numerous small wells. Even where regulation is, in principle, feasible, for legal and historical reasons much groundwater continues to be unregulated.

Quotas versus Prices

Three main conclusions can be drawn from the above review. First, and most obviously, incentive pricing requires volumetric management and is thus precluded in the vast majority of developing country situations, at least at farm level. Second, even if volumetric supply is assured at farm level, in practice, price incentives are predominantly used at the margin to control use in excess of defined quotas or rights. This gives users some flexibility, whether water is distributed by 'arranged demand' or is under the control of users. This provides incentives for water saving, but falls short of true irrigation on demand. Third, even for systems that approach on-demand irrigation and have the capacity to meet peak demands, rights are capped by a quota and suspended (e.g. in favour of rotational distribution) during droughts since irrigation invariably receives low priority.

In other words, even in the rare cases where conditions are met to regulate demand through pricing, supply is instead invariably managed through administered quotas or water rights. Reasons for the predominance of quotas include: (i) transparency; (ii) ability to ensure equity when supply is inadequate; (iii) administrative simplicity and relatively low transaction costs; (iv) capacity for bringing water use directly in line with continuously varying available resources; and (v) limited income losses incurred (as compared with price regulation). 'When water is scarce, the surest and most common way to make customers use less water is to limit supply' (Cornish *et al.*, 2004) and this has been easily the most favoured solution for restraining demand (Bate, 2002).[20]

But quotas also have their drawbacks (Bate, 2002; Chohin-Kuper *et al.*, 2002; Tsur, 2005). While price or market regulation tends to promote economic efficiency at the cost of equity (Okun, 1975), quotas (when non-transferable) foster equity at the cost of efficiency: they can lack flexibility in response to changing circumstances, as in the case of settlement quotas in Israel.[21] Equity is also weakened in the case of conjunctive use of

[20]The virtues of rationing (in the short term) and/or the allocation of quotas (for long-term allocation) are getting more attention from the World Bank (2006) who reckoned that 'quotas work better than prices when water users are not very responsive to water price changes'. Bosworth *et al.* (2004) also concluded that 'getting the prices right' is not the most appropriate solution to managing scarcity.

[21]The Israeli case is instructive of the difficulty to readjust quotas once they have been defined and, at the same time, of the growing mismatch which can materialize between one village quota and its real use or needs (Plaut, 2000). The trajectories of kibbutzim and cooperatives depend not only on many factors, including ethnic composition, level of education and political linkages, but also on the links to markets, the availability of non-agricultural opportunities and the possible development of additional local resources (Lees, 1998). With time, some settlements (and some farmers within each settlement) tend to intensify agriculture, while others shift to partial farming. Resulting imbalances between quotas and needs have led to some inefficiency; in the 1980s, some farmers would irrigate carelessly so as to fully use their quota for fear of seeing it reduced (Lees, 1998); and trading within as well as between communities has emerged (Kislev, 2005).

canal water and groundwater, where quotas are rarely adjusted to rebalance overall combined supply (like in Morocco). In practice, quotas also often integrate pre-existing local systems of rights (see the Jordan valley in Venot *et al.*, Chapter 10, this volume). In the absence of an 'omniscient allocator', reallocation can be done either through rules that embody desired priority principles or by making quotas tradable, or by a combination of both in order to address equity concerns while promoting efficient allocations (Seagraves and Easter, 1983; Bjornlund and McKay, 1999; Johansson *et al.*, 2002).

It is true that management of quotas cannot fully simulate the economic scarcity signals of a market price. But, given the socio-economic and practical constraints, and the political costs of promoting irrigation pricing for managing scarcity, the management of quotas (the 'visible hand of scarcity') appears a far more satisfactory and practical solution to water savings in almost all real-life circumstances. Even in Europe, where pricing is being strongly promoted, Garrido's (2002) review concluded that 'irrigation pricing reforms should not expect significant reductions in farmers' water consumption' and that 'efficient allocation can be made without prices'. It should be noted that this conclusion does not rule out on-demand irrigation when feasible and cost-effective. Also, it does not rule out the development of regulated markets in water rights (or quotas) where willing buyers and willing sellers cooperate to transfer water from low-value to high-value uses (see later section).

PRICING AS AN ECONOMIC INSTRUMENT: CROP AND TECHNOLOGICAL CHANGE

Shifts in Cropping Patterns

Governments often seek to promote agricultural diversification. This may be to save water but the primary objective is to generally promote agricultural growth and raise farm incomes. Some equate the two, arguing that, if the price of water is raised (ideally to its opportunity cost), low-value crops are less attractive and farmers shift to higher-value crops (Rosegrant *et al.*, 1995[22]; Bazza and Ahmad, 2002). In principle, of course, it is true that water-intensive crops become increasingly less profitable relative to less water-using crops if water charges are increased. But in practice, because water costs usually comprise only a small part of farm costs, very high increases in water costs and attendant income reduction are necessary to make these less water-intensive crops more attractive. This is illustrated in Fig. 2.8. Assuming that coefficients are fixed, crop shifts are costless and other costs and prices remain the same, the charge per cubic metre at which crop A (net income 100, water costs of 10 deducted) becomes less profitable than crop B80 (initial net income 80% of crop A, water needs 50% of crop A) is five times the initial charge, while income is slashed by 40%.[23]

Possible 'crops B' will be available to the farmer only where these have a net income comparable to crop A and where water costs are already relatively (very) high. This is rare in practice but occurs in private pressurized irrigation with high fixed costs (Charentes, France: Moynier, 2006), particularly in some groundwater areas (e.g. in Spain, Varela-Ortega, Chapter 14, this volume) where the alternative is rain-fed agriculture.

Of course, a more favourable outcome would be to see farmers adopting higher-value crops instead of lower-value crops. Although such a shift is frequently expected from

[22]'We argue that valuation of water at its opportunity cost will provide incentives for farmers to shift from water-intensive rice to higher-valued, less water-intensive crops after wet-season rice; and in other environments to shift from field crops to fruits and vegetables' (Rosegrant et *al.*, 1995).

[23]For crops B60 and B40 which have initial net income of 60% and 40% of crop A, the increases are even more massive (see Fig. 2.8). Even in the case where water costs represent 30% of the initial net income (a very high value) crop B80 becomes more profitable after multiplying water costs by 2.3, *but* with an unchanged income loss (40%).

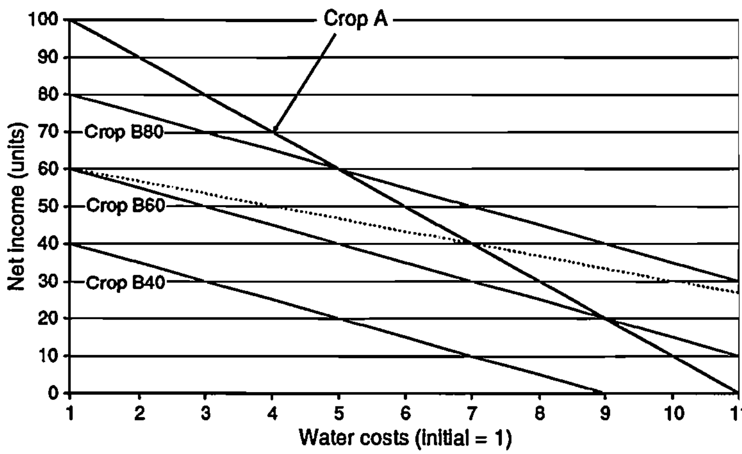

Fig. 2.8. Decrease of crop profitability with water costs.

increased prices, one may wonder in the first place why farmers would have neglected such an opportunity since it was already available to them, and why they would have to wait to see their benefits reduced by higher water costs before adopting it. This will enable us to get a closer scrutiny at farmer decision making regarding crop selection.

It must also be noted that high water use does not always imply low profitability and vice versa. 'Thirsty' crops with high returns include bananas (e.g. Jordan), rice (e.g. Egypt, Iran), sugarcane (parts of India) and qat (Yemen). Lucerne may consume a lot of water but does not have to be low-value, e.g. when in rotation with cereals. Above all, paddy is seldom grown *because* water is free or cheap (Falkenmark and Lundqvist, 1998) but in response to numerous environmental, social and other factors. Crops with lower requirements may not increase farmer incomes (and vice versa) and the impact on water productivity is far from self-evident. When high-value crops are also more water-intensive, higher prices may cause an increase in total demand for water, a phenomenon Dinar and Zilberman (1991) called 'the expansion effect'. In sum, the objectives of farmers (per hactare income), managers (reduce demand) or economists (water productivity) often do not coincide, although policies sometimes posit otherwise.

Economic growth, structural change and urbanization fuel demand for high-value products such as fruits, vegetables and meat (Rao *et al.*, 2004). Although the value of agricultural exports has risen dramatically, cereals continue to occupy more than 50% of the cultivated area worldwide, and fruits, vegetables and related high-value crops are confined to less than 7.5%. No doubt this share will rise but market constraints remain limiting, and cultivation must inevitably be confined to entrepreneurial farmers able to assume the costs and risks of high-return commercial agriculture. Access to groundwater greatly reduces water and related risks, but financial strength, entrepreneurial enterprise and credit access are still all required. Market volatility generates income instability (Hazell *et al.*, 1989; Quiroz and Valdés, 1995; Combes and Guillaumont, 2002) and most poor farmers cannot be expected to incur such risks, even if market volatility can sometimes be moderated by state interventions.

In addition to financial and marketing risk, crop choice is governed by a host of other well-identified factors.[24] These factors

[24]See, for example, Ellis (1998), Pingali and Rosegrant (1995) Quiroz and Valdés (1995), Pingali (2004), Arrojo (2001), Varela-Ortega *et al.* (1998), Dorjee *et al.* (2003); Barghouti *et al.* (2004), Gómez-Limón and Riesgo (2005), Binswanger and Rosenzweig (1986), World Bank (1988).

include: (i) labour constraints; (ii) lack of capital, credit or desire to get indebted; (iii) lack of information on market demand, quality requirements, agricultural techniques and agrochemicals, or adequate skills, etc.; (iv) land tenure uncertainty that hinders investments and adoption of perennial crops; (v) drudgery and health risk; (vi) soil, drainage or climatic constraints; (vii) high marketing costs due to poor transportation means (Delgado, 1995; World Bank, 2005a) and lack of infrastructure (cold storage trucking, refrigeration, etc.) (Barghouti *et al.*, 2004); (viii) the (un)reliability of irrigation supply and possible water quality constraints (Burt and Styles, 1999); and (ix) farmers' strategies, including food security considerations and many ageing farmers with exit strategies and no desire to take risk with new ventures, or to face increased drudgery.

This reminder serves here to dampen the enthusiasm that farm economic problems can be solved by a sweeping shift to high-value, capital-intensive and entrepreneurial agriculture. Another consequence is that farm models that seek to explain crop choice using fixed coefficients and oversimplified decision-making models fail to capture farmer responses, constraints and risks in full, with the implication that modelling approaches probably overstate the mobility of farming systems and their response to prices. Also, the responses are not confined just to farm practices. Farmers bring political pressure to bear when charges are raised and/or may refuse to meet obligations they consider punitive or unfair, break structures, tamper with metres or collude with field staff. Sanctions are difficult – even impossible – to enforce where control at the farm level is so often illusory.

In contrast to water charges, rationing and supply management can be very effective in influencing crop choice. The reasons are perhaps obvious. That water costs are seldom a critical issue does not mean that water is not a critical input. Farmers' indiscipline undermines supply management practices and, faced by shortages, deficit irrigation is a first response. But if schedules and quotas are strictly enforced, farmers perforce have to change their cropping patterns (or equipment) if basic water supplies are insufficient to meet minimum crop water requirements. Besides being a mechanism for managing scarcity and bringing supply and demand into immediate balance, supply management thus impacts on crop choice both in the short and (if sustained year to year) the long term.

Technological Change

By far the most important response to water scarcity has been the tube well revolution. Groundwater accounts for as much as 50% of agricultural value-added under irrigation, with much of it within the boundaries of surface irrigation schemes. Investment in water-saving technologies – buried pipes, sprinklers, micro-irrigation, land-levelling – represents a further response to water scarcity and to consequent high water costs. However, water is not the only factor involved. A profit-maximizing farmer, in principle, invests when (financial) capital and future O&M costs are justified in terms of anticipated increases in net income. Both farmers and conditions vary widely, and the decision to invest in costly equipment is seldom a straightforward response to water conditions but reflects a host of interconnected factors (Caswell and Zilberman, 1985; Green *et al.*, 1996; Schuck and Green, 2001; Moreno and Sunding, 2005). These may include[25]: (i) feasible crops; (ii) environmental conditions (soil quality, slope, plot size and shape, wind, water quality, etc.); (iii) the presence or absence of equipment suppliers and after-sales service; (iv) farmer education, skills, financial capacity and entrepreneurial spirit; (v) the amortization of existing material; and (vi) market opportunities, costs and risks.

[25]For discussion on the adoption of irrigation technology see also de Fraiture and Perry (Chapter 3, this volume), Green and Sunding (1997), Varela-Ortega *et al.* (1998), Dinar and Yaron (1990), Lichtenberg (1989), Sunding (2005), Green *et al.* (1996), Sumpsi Viñas (1998), Molle (2006), Green *et al.* (1996), Scheierling *et al.* (2006b), Dinar and Zilberman (1994), Schuck *et al.* (2005), Skaggs (2001), Shrestha and Gopalakrishnan (1993), Moreno and Sunding (2000).

Moreover, even discounting for risk and associated factors, profit maximization is not always the farmer's major preoccupation. Cropping in Jordan, for instance, can be explained in part by considerations of prestige and leisure (Venot *et al.*, Chapter 10, this volume).

Supply management and regulation of water use are sometimes used to dictate farm-level investments in water-saving technologies based on beneficial use or similar grounds. Some governments, supported in many cases by donor agencies, go further and subsidize such investments. Beyond initiating research and pilot schemes, however, such programmes are generally self-defeating, leading to overproduction, accentuated price volatility and discrimination against those who fail to obtain subsidies. Farmers are invariably the best judge of the investments justified in their own circumstances, and governments should limit their role to the regulation of water rights and water use so as to manage conflict, enable reallocation and promote environmental sustainability. Given extensive groundwater capacities, there is in particular little point in subsidizing modern water-saving technologies in massive surface systems which cannot compete with groundwater and which will inevitably remain largely for the production of cereals and other traditional crops.

Pricing, Crops and Technological Change: Empirical Evidence

Agricultural diversification and investments in water-savings technologies often go together, but are driven by market opportunities and total farming conditions rather than by water prices. Broad reviews at national level include that by Yang *et al.* (2003), who conclude that despite strong promotion of agricultural diversification 'the pace of this shift has not accelerated ... [due to] constraints of marketing channels, processing and transport facilities, and market demand . . . particularly for perishable crops, such as vegetables and fruits'. With market saturation in many markets, they conclude that 'further raising irrigation charges are unlikely to lead to a substantial shift to cash crops'. Siriluck and Kammeier (2003) analysed a nationwide project aimed at fostering agricultural diversification in Thailand. They found that extension and credit packages may encourage some diversification but that 'blueprint' approaches insensitive to household diversity may push farmers into risky ventures and indebtedness. Artificially boosting output of specialty cash crops often sends market prices down, thus reducing the initial benefits of the shift and increasing the risk of bankruptcy.

Case studies provide similar conclusions. Both linear programming at farm and system level, and econometric models have attempted to capture the impact of pricing on cropping patterns and investments. Such models typically assume that farmers are profit-maximizing agents (Pinheiro and Saraiva, 2005), but differ greatly in their treatment of risk and other factors. Price elasticities and other outputs of such models heavily depend on the context, the assumptions made, the variables retained and the adjustments farmers are allowed to make (Ogg and Gollehon, 1989; Scheierling *et al.*, 2004). Most studies are from developed countries (western USA, Israel and southern Europe) and assume volumetric control and water on demand. In Spain, for instance, Varela-Ortega *et al.* (1998) show that to obtain a 10% reduction in water consumption 'irrigators of the Valencia region have to sacrifice up to 70% of their income, compared to 57% of their counterpart in the Castille region and a small 9% in Andalusia'. The low value in Andalusia is explained by the productive potential of this region, its large farms and the availability of alternative crops. Sumpsi Viñas (1998) obtained similar results for the Balbilafuente scheme, concluding that the elasticity of demand depends on farm size, initial water endowments, available crop alternatives and strategies of production (intensive or extensive), all of which differ regionally. Berbel and Gomez-Limón (2000) show for the Guadalquivir and Duero basins that farm incomes have to be decreased by 25% and 49%, respectively, before water demand decreases significantly. These and numerous other studies in Europe (Gómez-Limón and Riesgo, 2004a,b for Spain; Morris *et al.*, 2005 for the UK; Bazzani *et al.*, 2005 and Gallerani *et al.*, 2005 for Italy; Pinheiro and Saraiva, 2005 for Portugal), although undertaken in differing contexts with differing assumptions, hypotheses and coverage, tend to converge on a number of common conclusions:

- Response to price tends to be high for extensive and low for intensive high-value agriculture and depends on the number of crops that can be grown in any given region (which may be limited).
- Water savings due to crop or technological shifts only occur at price levels that severely dent farmers' incomes. If irrigation is extensive or has been developed as a social investment, large subsidies are needed to preserve farming after modernization.
- Water demand under micro-irrigation is inelastic. Once improvements in water-use efficiency have been achieved due to its adoption, further gains are increasingly unlikely.
- Water agency receipts often increase as water prices rise, though this is sometimes more than offset by reductions in water use.
- Because regions, and farmers within regions, are heterogeneous, nationwide policies will not be successful and have negative impacts on those who cannot adjust.

Many of these studies point to the adverse economic and political consequences of raising prices to levels that could impact on cropping and/or technology. Raising water prices sufficiently to impact on use and technology is not only a blunt instrument with widely differing regional impacts, but often results in irrigation becoming unprofitable. The decision on whether to provide subsidies forms part of a wider discussion on agricultural protection – the implication being that quotas are more effective in limiting water use if the concurrent aim is to preserve farm incomes and farming communities.

US studies have more mixed conclusions. While some are in agreement with these conclusions (e.g. Scheierling *et al.*, 2004 for South Platte; Scheierling *et al.*, 2006a,b; Hoyt, 1984; Caswell *et al.*, 1990), others suggest that technological change can occur in response to price (Caswell and Zilberman, 1985; Nieswiadomy, 1985; Negri and Brooks, 1990; Moore *et al.*, 1994). The reasons are unclear but some of the latter US studies appear to fail to establish a satisfactory level of causality between the water price and technological investment (Sunding, 2005), while others do not explore income losses and subsidies sufficiently to be comparable with the European studies. Be that as it may, there are many examples showing that water prices are seldom the primary driver in the adoption of water-saving technology since investment costs are almost invariably far greater than any savings in the water bill. Perry (2001a,b) shows, for central Iran, that the cost of reducing deliveries via such technologies is twice the actual cost of supply by the agency. In Gujarat, tube well farmers have complete flexibility and pay more than 30% of their net income for water, but there is little investment in improved technologies (Cornish *et al.*, 2004). De Fraiture and Perry (Chapter 3, this volume) conclude that 'empirical evidence shows that technology choice is hardly driven by water price' and Varela-Ortega *et al.* (1998) argue that 'the adoption of irrigation technology is not the most significant response to water pricing policies . . . technology adoption in highly productive regions can come about at zero water price rates'. In India (Shah *et al.*, Chapter 9, this volume) or in the Jordan valley (Venot *et al.*, Chapter 10, this volume), micro-irrigation developed when the price was very low, and Sunding (2005) concludes that 'water price is not the most important factor governing irrigation technology adoption' in San Joaquim valley; dissemination of centre pivots in California occurred when water costs were irrelevant (McKnight, 1983).

In practice, investment in water-saving technologies is linked to numerous other interacting factors (Dinar and Zilberman, 1994; Scheierling *et al.*, 2004). Diffusion of drip irrigation in Israel, for instance, was spurred by: (i) higher yields; (ii) subsidies; (iii) sandy soils; and (iv) the reuse of water savings to expand cultivation (Dinar and Zilberman, 1994). In other cases, produce quality (e.g. potatoes in the UK) and reduced labour costs are paramount. Calculations made by Sumpsi Viñas (1998) for vegetable and fruit production in several regions of Spain showed that impacts on yield, quality and labour use make drip and sprinklers more profitable than furrow irrigation. In Hawaii, drip irrigation was widespread in sugarcane because it increased yields, saved labour (and some water) and allowed expansion of cultivation on marginal and sandy soils (Shrestha and Gopalakrishnan, 1993). In Tunisia, although modernization targeted water saving, on-farm water use was not significantly altered, though higher yields and incomes were obtained (Al-Atiri *et al.*, 2004). García Mollá's (2000) study of Valencia in Spain and Carles *et al.*'s (1999) review of nine irrigation schemes also demonstrated that adoption of drip irrigation was motivated by reduced labour, enhanced quality, convenience and fertilizer saving.

Finally, contrary to common wisdom, the use of water-saving technology at the farm level does not necessarily mean that the fraction of applied water that is depleted (actually transpired or evaporated to the atmosphere) has been reduced. Soil evaporation is often reduced but crop evaporation is generally increased because of better and timelier application (Burt *et al.*, 2001; Perry, 2001a,b). Furthermore, evidence from arid and semi-arid regions, and more generally if land is not a limiting factor, suggests that water savings, to the extent they are obtained, are generally retained by the farmer or his neighbours to expand the cropped area. While benefits accrue to those expanding this area, the fraction of water depleted typically rises and return flows and aquifer recharge decline. García Mollá's (2000) study in Valencia revealed that districts adopting drip irrigation have attempted to maximize the area under cultivation. Similar situations have been described in countries such as Tunisia (Feuillette, 2001), India (Moench *et al.*, 2003), Spain (Carles *et al.*, 1999), Israel (Dinar and Zilberman, 1994), Morocco, the USA (Caswell, 1998; Huffaker *et al.*, 2000; Skaggs, 2001; Aillery and Gollehon, 2003; Huffaker and Whittlesey, 2003) and Hawaii (Shrestha and Gopalakrishnan, 1993). Public subsidies[26] aimed at improving efficiencies and releasing water for other uses are thus often counterproductive.

In sum, adoption of water-saving technology is seldom driven by water scarcity or water prices, but by an association of benefits that play out together: yield increases allowed by better and more homogeneous application of water, better quality and a more homogeneous product, bringing substantial increases in the market price, better application of fertilizers and chemicals, decreased labour costs, decrease in return flows contributing to reducing the leaching of fertilizer and pesticides and to controlling soil erosion are some of the associated benefits.[27] Further incentives are clearly linked to the possibility of using water savings to expand cultivation where land is not a constraint, and to that of capitalizing on existing pressurized supply when water is pumped from wells (Caswell and Zilberman, 1985; García Mollá, 2000; Becker and Lavee,

[26]Many countries subsidize micro-irrigation and farm-level improvement. In Morocco, for example, they are subsidized at a level of 30–40% and farmers are granted bonuses (Belghiti, 2005a) because technologies are too costly for farmers, but even then adoption is slow (Tizaoui, 2004). In Israel, micro-irrigation is generalized but the growth of 700% observed during 1975–1982 was spurred by heavy government subsidies that made the shift profitable (Shevah and Kohen, 1997). In the USA, the conservation of groundwater and surface water has been promoted by the Environmental Quality Incentives Program initiated in 1997, whereby cost-sharing may pay up to 75% of the costs of eligible conservation practices (Scheierling *et al.*, 2006a).

[27]For further discussion, refer to Caswell and Zilberman (1985, 1990), Dinar and Zilberman (1991, 1994), Caswell (1998), Morris *et al.* (2005), Wierenga and Hendrickx (1985), Carles *et al.* (1999), Skaggs (2001), Sumpsi Viñas (1998), McKnight (1983), Scheierling *et al.* (2006a), Becker and Lavee (2002) and García Mollá (2000).

2002). As a rule, these shifts generally result more from changes in market opportunities, output prices and subsidies (e.g. the Common Agricultural Policy (CAP) in Europe) than from changes in input costs.

PRICING AS AN ECONOMIC INSTRUMENT: ALLOCATION BETWEEN SECTORS[28]

Introduction

Urban growth and industrialization fuel rising water demands. According to the World Bank Strategy of 1993 'setting prices at the right level is not enough; prices need to be paid if they are to enhance the efficient allocation of resources' (World Bank, 1993); for Johansson (2000): 'The fundamental role of prices is to help allocate scarce resources among competing uses and users. One way to achieve an efficient allocation of water is to price its consumption correctly.' With higher prices that reflect opportunity cost, the reasoning goes, low-value activities are phased out, thus releasing water for high-value uses and raising social welfare.

As water shifts, *allocation stress*[29] moderates and economic gains are realized (Dinar, 1998; Rosegrant and Cline, 2002; Merrett, 2003; Hansen and Bhatia, 2004): 'supporting 100,000 high-tech California jobs requires some 250 million gallons of water a year; the same amount of water used in the agricultural sector sustains fewer than 10 jobs, a stunning difference' (Gleick, 2000). Elsewhere Gleick says: 'as much as half of all water diverted for agriculture never yields any food. Thus even modest improvements in agricultural efficiency could free up huge quantities of water.' But these and similar statements[30] need to be challenged. It is true that irrigation consumes much more water than urban uses, both absolutely and relative to diversions, but this is inherent to the activity (Abernethy, 2005) and it does not follow that increased 'agricultural efficiency' is a precondition for meeting other needs. To recapitulate:

- Irrigation may use uncontrolled and other marginal sources that may be unable to provide the security and quality needed by domestic or industrial users (Savenije and van der Zaag, 2002).
- There may be no hydraulic connectivity between irrigation and potential urban uses, and transfers and storage may be impracticable or prohibitively expensive (Smith *et al.*, 1997).
- Basin efficiencies are much higher than subsystem efficiencies (Frederiksen, 1996; Keller *et al.*, 1996; Perry, 1999; Molle *et al.*, 2004).
- Response to scarcity means that farmers use water more efficiently than is commonly assumed, adopting conservation measures and conjunctive use that offset the impact of reduced supply.

Moreover, if reallocation of water becomes necessary and is feasible, this almost invariably occurs, though not necessarily at lowest cost or in the most sustainable manner. Deficiencies in urban systems are thus primarily due to financial constraints and political priorities, and not to water being 'locked up' in 'inefficient' irrigation. The following subsections review these issues further under three headings: (i) allocation or financial stress?; (ii) transfer mechanisms; and (iii) implications. Issues associated with environmental externalities are discussed in the next section.

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[28]This section is largely derived from Molle and Berkoff (2006), to which the reader is referred for further details.

[29]The allocation stress is typified by Bate (2002): 'The effect of under-priced water is that farmers use inefficient irrigation technologies to produce uneconomic goods at the expense of lucrative alternative economic activities.' The opportunity costs of this misallocation can be vast. See also Dinar and Subramanian (1997).

[30]See similar statements in Winpenny (1997), Simon (1998), IRN (2003), Postel (2001), Hansen and Bhatia (2004), ESCWA (1999) and Colby (1990), among others.

Allocation or Financial Stress?

Allocation stress

Allocation stress is said to occur when high-value sectors are deprived of water that is locked into lower-value activities. But the existence of a significant allocation gap is doubtful. In practice, farmers are 'losing out' (Winpenny, 1994), urban interests get the 'upper hand' (Lundqvist, 1993) and 'cities will continue to siphon water away from agriculture' (Postel, 1999). Transfers out of agriculture or ecological reserves (to the extent necessary and feasible) may be minor or major, gradual or outright, surreptitious or open, on the surface or underground, and with or without compensation, but by and large cities procure the water they need (Molle and Berkoff, 2006), in both the shorter and longer terms.

Priority in a drought is almost invariably given to urban uses, and to industry and services in particular. For example, shortages in industry and tourism in the 'Eastern Seaboard' near Bangkok have been quickly diffused by the implementation of six inter-basin transfers and drilling of 290 artesian wells for short-term relief (Samabuddhi, 2005).[31] Page (2001) cites a survey of the Hebei province that showed 'how local officials enforced restrictions on farmers but overlooked those on industry to lure projects from which they could profit'. Amman's supply was hardly impacted by the 2000/01 drought; the California State Water Project cut-off farmers in 1991, and the Bureau of Reclamation reduced supplies in the Central Valley by 75% (Anderson and Snyder, 1997); Jakarta's golf courses were supplied in the major 1994 drought; and in Cyprus farm supplies were cut by 50% in a 3-year drought but supplies to the 2 million tourists were maintained (Barlow and Clarke, 2003). Other examples where agriculture suffered first include Chennai, India (Ramakrishnan, 2002), the Guadaquiver basin in Spain (Fereres and Cena, 1997), the Alentejo region in Portugal (Caldas *et al.*, 1997) and Manila (McIntosh, 2003).

Whether longer-term investments in services and industry are constrained by water remains perhaps a matter of debate. Very high water-consuming industries, such as aluminium, are unlikely to settle in water-short areas, and suggestions have been made that water-intensive industries should be moved, e.g. inland from coastal China (Chan and Shimou, 1999). Many cities appear to be in the *wrong* place (Winpenny, 1994) and have to opt for more distant and costly transfers after exhausting nearby water supplies. But they can still continue to grow rapidly: Chennai, Mexico City, Las Vegas, Tianjin and Amman are widely differing cities that all illustrate this despite their very limited nearby resources. Ta'iz grew by 7.9% between 1986 and 1994, despite being one of the most water-stressed cities in the world. Even in water-abundant areas, cities outstrip proximate resources when located in upper catchments (e.g. São Paulo, Atlanta, Kuala Lumpur) or in small coastal catchments (e.g. Manila, New York, Boston). Although the costs of water vary greatly depending on local circumstances, there is little evidence that water constraints seriously impact on urban growth; and when this is the case it is rarely due to water being locked up in agriculture, except in situations where formal water rights may dictate so (e.g. western USA).

Financial and political stress

That cities, by and large, are able to obtain the water they need does not, of course, mean that water supply and sanitation (WSS) services have no deficiencies. Far from it. But these deficiencies reflect political priorities and financial constraints rather than water availability as such. In Europe for instance, in historic times, extension of WSS facilities beyond the affluent

[31] The Finance Minister is reported to have told senior bureaucrats that their 'heads are pledged as a guarantee, since this issue is a problem for the entire country . . . I don't want to hear again that industries along the Eastern Seaboard are facing water problems, whether it's this year or in any other year'.

can be attributed to a combination of the hygienist movement, a perceived 'threat from below' (Chaplin, 1999) and/or the need 'to preserve order, cleanliness and a healthy workforce' (Goubert, 1986). As early as the mid-18th century it was recognized that 'prevention of further environmental degradation was cheaper and more effective . . . than continuing with expenditure on poor relief' (Chaplin, 1999). Elites in Guayaquil (Swyngedouw, 2003) and Monterrey (Bennett, 1995) reacted in more recent times to social unrest. In contrast, Chaplin (1999) attributes the negative picture in India to a failure by the upper classes to pressure the government to invest. WSS investments differ in their political rewards and the key question is 'who will pay?' rather than 'where is the water?'.

Political considerations are compounded by financial and institutional constraints. Few cities in developing countries have been able to keep pace with inward migration (Lundqvist *et al.*, 2003) and the costs of collecting, conveying and disposing of water in line with city expansion have proven beyond their financial capacity. This has generally remained true throughout their history, when the population was far lower than now just as much as once the mega-cities of the present day had developed. Even in water-abundant regions, developing country cities have deficient WSS systems (e.g. Lagos, Dhaka, and Ho Chi Minh City). 'The root cause [of poor water supply to population] is our negligence and our resignation in the face of inequality' (Camdessus and Winpenny, 2003). Other documents addressing this issue similarly fail to refer to physical scarcity as a constraint (Anton, 1995; UNESCO, 2003). The question of 'who will pay' is key to understanding WSS conditions in cities. Capital cities are particularly well placed to access public funds (e.g. Mexico: Connolly, 1999) and how taxes are shared between local bodies, and state and federal governments, has an important bearing on the outcome. Some cities attract foreign subsidies (e.g. EU funds for Athens) or benefit from geopolitical considerations (e.g. Amman) or broad reconstruction factors (e.g. Phnom Penh). If society is receptive to privatization, the financial burden can be shifted to users, as in the UK, but elsewhere privatization and public–private partnerships have had mixed results in view of the risks, poor financial returns and political sensitivities (SIWI, 2004).

By and large, cities can secure necessary water resources. The mechanisms adopted to achieve the transfer, however, vary greatly. They depend, in particular, on the characteristics of the hydrological system, the nature and practice of government and on the strength of the regulatory and water rights systems. They are discussed below under three headings: expropriation (with and without compensation), opportunity cost pricing and markets.

Reallocation: Bureaucratic Expropriation, Administered Prices and Markets

Expropriation

An extensive literature review suggests that governments, urban utilities and industries commonly reallocate water by bureaucratic action (Molle and Berkoff, 2006). When successive urban projects take amounts that are small relative to river flows, reallocation can occur by stealth, with the impact on downstream farmers and ecosystems obscured by natural hydrologic variability. Even more prevalent than such reallocation of surface flows is the 'hidden' expropriation of groundwater resources as urban users deepen wells and increase pumping: approximately 1.5–2.0 billion people are said to rely on groundwater for domestic consumption, including 1 billion urban inhabitants in Asia (Foster, 1999), and industries often access groundwater directly because it is secure and needs no treatment. Where confiscation by stealth is impracticable, utilities may exercise *force majeure* – supported by politicians – and deprive farmers and other users outright. Since property rights are seldom clearly demarcated, confiscation may be legal in the sense that governments usually retain the final say on who receives water in the national interest. A further argument used to rationalize direct confiscation is that irrigation was a (heavily subsidized) gift of government in the first place. In cases where formal rights are effective, expropriation is precluded in the absence of financial compensation.

Expropriation is, in its nature, inequitable, depriving farmers of their traditional livelihood without recourse, accelerating the process of structural change and aggravating income inequities. Thus, although it is conceptually the simplest mechanism for effecting water transfers, direct expropriation can be problematic for any government, even an authoritarian one, especially in contexts where the local economy revolves around irrigated agriculture. This has led governments to consider compensation schemes on a case-by-case basis, even where formal property rights do not exist. This can take the form of *either* complementary action to ensure that the impact on irrigation is minimized *or* financial compensation for the losses incurred.

An example of complementary action was by El Paso which obtained water from the Rio Grande on condition that it reduced per capita consumption, recycled sewage water and eliminated leakage (Earl, 1996). Dongyang city obtained water from a dam managed by the Yiwu city, but had to finance an increase in the height of the dam and line irrigation canals (Liu, 2003). The 1998 agreement between the Imperial Valley Irrigation district and the Southern California Metropolitan Water Authority (MWA) included the lining of the All-American Canal by MWA with usufruct rights to the 100 Mm^3 thought to be 'conserved' passed to Southern California metropolitan area (Cortez-Lara and Garcia-Acevedo, 2000); similarly, the Upper Ganga canal was lined so that 'seepage losses' could be reallocated to Delhi. In both cases, however, these transfers were in practice at the expense of downstream groundwater users, who in the Californian case were Mexican farmers. Molle *et al.* (2004) use an example from Central Iran to show that in 'closed basins', where most or all resources are committed (often overcommitted), conservation measures do not save water, but merely reallocate it across the basin in a way that is not always perceptible.

Examples of compensation for water transfers include the buying out of agricultural wells around some cities (e.g. in Phoenix or Chennai); the diversion of water from neighbouring irrigation reservoirs to serve cities (e.g. Tsingtao in China where irrigation reservoirs were converted to urban use in preference to paying higher rates for Yellow River water); and the purchase of reservoir storage for hydro-generation from farmers during droughts in the Guadalquivir River basin, Spain. The merit of these and similar arrangements is that the transfer between irrigation and the utility can be adapted to specific local realities to the benefit of both sides. The government ultimately acts as mediator between the two and as the guarantor that the agreement will be honoured.

Opportunity cost pricing

Rather than expropriate water – with or without compensation – transfers can, in principle, be forced by full economic pricing of supply.[32] The World Bank's 1993 water policy and repetition by resource economists has disseminated the idea of the need for reallocation from low- to high-value uses, and this idea has been incorporated in national policy and legal documents. Zimbabwe's 1994 Irrigation Policy and Strategy, for example, states: 'Since water is scarce, its opportunity cost should be taken into consideration in determining price' (Nyoni, 1999). Despite these intentions and policies, however, charging economic prices

[32]While some see this as a desirable or compelling objective (although some phasing might be necessary to get there) (Khanna and Sheng, 2000; Rosegrant *et al.*, 1995; EU, 2000a; GWP-TAC, 2000; Plaut, 2000; Socratous, 2000; Saleth, 2001; Ünver and Gupta, 2003), others admit that it might be a far-fetched – or impractical – objective, especially when not even O&M costs are recovered) (Sampath, 1992; Smith *et al.*, 1997; Thobani, 1997; Asad *et al.*, 1999; Garrido, 2002; World Bank, 2003b).

has in practice remained elusive (Bosworth *et al.*, 2002; Kulshreshtha, 2002; ICID, 2004). Acknowledging the 'yawning gap between simple economic principles . . . and on-the-ground reality' that has prevailed for decades, the World Bank (2003) reconsidered the issue and singled out two main reasons for this gap: first, the impossibility 'to explain to the general public (let alone to angry farmers) why they should pay for something that doesn't cost anything to produce'; and second, the fact that 'those who have implicit or explicit rights to use of the resource consider (appropriately) such proposals to be the confiscation of property' (see Molle and Berkoff, Chapter 1, this volume).

A further reason why economic pricing is impractical (Asad *et al.*, 1999) and has seldom if ever been adopted (ICID, 2004) is that opportunity costs are location- and time-specific, and operate at the margin, falling off drastically once effective urban demand at any specific location has been satisfied (Savenije and van der Zaag, 2002). Moreover, the opportunity cost price does not equal the full opportunity value in urban uses but an intermediate value determined by the shape of the relevant demand curves given that a fixed amount of water must be allocated between competing uses when externality and other costs vary (Green, 2003). Even if this price could, in practice, be estimated, the implication is that high charges would be paid by those in irrigation schemes in direct competition with neighbouring urban areas, and that those further away and not in competition would pay much lower prices. As noted earlier, charging for opportunity costs would also be politically and socially self-defeating since the order of magnitude of these costs would bankrupt most of the irrigation activities affected (Bate, 2002; Tardieu and Préfol, 2002; The Economist, 2003[33]), especially when irrigation is inherently uneconomic (first section). Despite these impediments, two countervailing arguments are sometimes asserted:

- Stripped of normative content with regard to price fixing, the estimation of opportunity values in alternative uses sheds light on how much is recovered from users, paid by the state and left uncovered. This is a central argument of the EU's Water Framework Directive.
- Even if full opportunity cost pricing is impracticable, moving towards higher water charges might still instil a degree of market logic, promote structural shifts in the rural community, and favour those who can make the best use of available irrigation supplies.

Charging opportunity costs is nevertheless comparable to expropriation in that those who lose their water as a result of an inability to pay receive no compensation (Cummings and Nercessiantz, 1992) and this can be perceived as expropriation by those who have customary rights or who have bought land with the value of water incorporated in the price (Rosegrant and Binswanger, 1994; Garrido, 1999; World Bank, 2003a,b). Given also the potential for inefficiency and rent-seeking in the context of bureaucratic involvement, many point to water markets as a preferable solution to either expropriation or opportunity cost pricing to resolve allocation problems (Thobani, 1997; Bate, 2002).

Market reallocation

Small-scale water markets have long existed. The ancient markets of Alicante are well known (Maass and Anderson, 1978). More generally, community-based irrigation supplied by springs or qanats (Beaumont *et al.*, 1989) often has well-defined individual rights that lend themselves to temporary or permanent transactions. Most occur in 'spot markets': neighbours swap, lend, borrow, sell or buy water turns in order to fine-tune supply to individual demands. This also

[33]*The Economist* (2003) emphasizes that it is not 'politically plausible to suggest that farmers must always pay the full costs of their water. Water for irrigation is highly price-inelastic: since farmers have little alternative but to use the stuff, charging the full cost could simply drive them into bankruptcy'.

occurs in large-scale irrigation systems if supply is sufficiently defined in terms of time or discharge to permit quantitative estimation (a notable example being the warabandi systems of Pakistan and north-west India). Recently, groundwater markets have spread in South Asia and elsewhere although these are perhaps more akin to buying of a service than of the water itself (Shah, 1993). At these scales, transaction costs are minimized because users know each other (Reidinger, 1994), can readily communicate, and transfers are across short distances without costly infrastructure or significant losses. Permanent transfer of ownership is also socially controlled and local third-party impacts are easily identified.

Traditional markets reallocated water primarily within agriculture, although conversion of wells to water supply for tanker markets also occurs (e.g. in Jordan and India). Market reallocation has also sometimes performed well at a larger scale when the institutional conditions allow. Examples include trading of Rio Grande water in Texas (Chang and Griffin, 1992), the Westlands Water District in California (Brozovic *et al.*, 2002) and the Colorado-Big-Thompson scheme (Howe, 1986; Mariño and Kemper, 1999), where most transactions are spot transactions and rental (Carey and Sunding, 2001), but also include permanent transfers from agriculture to other sectors (Howe and Goemans, 2003). In South Africa's Orange River basin, trading has occurred between commercial farms (Backeberg, 2006). In Australia, transfers within and among distant irrigated areas have developed in the last 10 years (90% being temporary transfers) (Isaac, 2002; Turral *et al.*, 2004). Bauer's (2004) review of the Chilean experience describes active markets in the Limari basin (mostly short-term reallocation between irrigators supplied by the same reservoir), and in the Maipo and Mapocho basins close to Santiago (4% of all water rights were traded between 1990 and 1997, half being acquired by municipal utilities: Alicera *et al.*, 1999). In Mexico, trading occurs within large irrigation schemes, but interstate transfers are closely regulated (Simpson and Ringskog, 1997).

As the scale and number of users increase, however, water's well-known characteristics (see first section) make it prone to market failure (Livingston, 1995). Defining property rights can be very difficult; economies of scale invite natural monopolies (Easter and Feder, 1998); and the transaction costs associated with markets – information, regulation and enforcement – are typically large. Above all, third-party and externality effects are pervasive, and it is often very difficult to link particular flows with particular uses or users. Markets in the USA have, for instance, been constrained by the lengthy and costly litigation to which third-party impacts often give rise (Dellapenna, 2000; Kenney, 2003; Libecap, 2003). Market transactions within the Colorado-Big-Thompson system may work well, but this is partly because they are confined within one water district that holds the right to all return flows (Howe and Goemans, 2003; Libecap, 2003). China suspended an experiment in interprovincial trading once the return flow and environmental impacts became evident (Fu and Hu, 2002).

Moreover, water markets fail to account for scheme- and regional-level impacts of transfers. The transfer of some water rights to non-agricultural investors attached to acequias in New Mexico, for example, weakened management and maintenance of the system as a whole (Klein-Robbenhaar, 1996). Frederick (1998) reports that 'when farmers want to sell water to cities, irrigation districts resist, fearing the loss of agricultural jobs', while Wahl (1993) acknowledges that 'most agricultural water districts have viewed the potential for water transfers only very tentatively out of concern over the security of their water rights and potentially adverse effects on the districts and local communities'. The severity of impacts on the area of origin varies greatly (Gopalakrishnan, 1973; Charney and Woodward, 1990; Howe *et al.*, 1990). Sunk costs in social and non-irrigation economic infrastructure, for instance, may be a strong argument for preserving irrigation, but cannot be reflected in a market price.

Finally, markets may open the door for opportunistic and monopolistic behaviour. Bjornlund and McKay (1999) observed that in Australia, opportunistic buyers were able to exert undue pressure on sellers to obtain lower prices. Bauer (1997) and Hadjigeorgalis (1999) showed that in Chile, 'many small farmers are liquidity-constrained and often have sold rights to pay off large debts'; as 'land is of little value without water . . . it is not expected to observe farmers selling water rights unless they were exiting agriculture or facing liquidity constraint'. In Australia, on the other hand, 57% of water permanently traded was due to farmers having excess water or reducing their irrigation areas (Turral *et al.*, 2004). In California, presumably, transfers between large commercial farms reflect mere shifts in economic opportunities.

Although attractive in principle, the complexity of establishing markets for tradable water rights is formidable (CEPAL, 1995; Livingston, 1995; Siamwalla and Roche, 2001). Positive experience is confined to countries (e.g. the USA, Australia and Chile) having a sound knowledge of hydrology; a comprehensive and modern hydraulic infrastructure (notably of storage); strong legal, institutional and regulatory backgrounds; and relatively wealthy stakeholders. Proposals for the adoption of markets in tradable rights in countries where hydrologic data are scarce, physical infrastructure is lacking, water rights are ill-defined, farmers are numerous and small, and states have generally weak and ill-developed monitoring and enforcement capacity are unrealistic for the foreseeable future (see, e.g., Tanzania in van Koppen *et al.*, Chapter 6, this volume).

Implications

Differences between administrative and market allocation are not perhaps as large as sometimes stated (Mariño and Kemper, 1999). They both require considerable knowledge of the hydrology, control of the water regime, a command over who uses what water where and when and mechanisms for enforcement and dispute resolution. Differences in the effectiveness of regulatory structures may well reveal cultural or ideological values – even local idiosyncrasies (e.g. preference for licenses in Japan or France: Tardieu and Préfol, 2002 or market mechanisms in Chile), rather than degrees of efficacy.

Differences of opinion nevertheless persist between those who emphasize government failure and those who emphasize market failure. The former view state bureaucracies as at best inefficient and at worst subject to corruption and rent-seeking (Rosegrant and Binswanger, 1994; Holden and Thobani, 1996; Thobani, 1997; Easter *et al.*, 1999) and – in the USA – consider that public welfare and public trust doctrines destroy private property and hinder transfers towards higher value uses (Anderson and Snyder, 1997; Gardner, 2003). However, the majority of observers are doubtful that markets can constitute a major tool for the reallocation of water, no matter how theoretically desirable they may be, most especially in developing countries (Colby, 1990; CEPAL, 1995; Livingston, 1995; Morris, 1996; Gaffney, 1997; Frederick, 1998; McNeill, 1998; Dellapenna, 2000; Meinzen-Dick and Appasamy, 2002; Libecap, 2003; Kenney, 2006; Solanes and Jouravlev, 2006).

Markets can no doubt be facilitated at community and local level (Brown, 1997), but water allocation at higher levels requires a 'delicate interplay' between administrative and market control. This 'delicate interplay' would perhaps be best served by a more systematic adoption of compensation arrangements that recognize the economic benefits from reallocation – and the fact that urban interests will obtain their water needs – and also ensure transparency and that the interests of those deprived are taken into account. Ideally, the urban utility and the affected farmers would negotiate face to face, with both in effect faced by the opportunity cost of the water in dispute. The government regulator would, in principle, act as moderator and guarantor, and intervene more generally to safeguard farmers' interests and ensure that environmental externalities and third-party effects are taken into account. No doubt such a system would be open to abuse (government failure would not be abolished), but as regulation strengthens, negotiated compensation could increasingly approximate to regulated markets in which the particular circumstances of the water in dispute are taken into account.

PRICING AS AN ENVIRONMENTAL INSTRUMENT: WATER QUALITY AND SUSTAINABILITY

Introduction

So long as diversions are small relative to the water resource, consumptive and in-stream users are unconstrained in what they do and most water is left to the natural environment as the default *user of last resort* (see first section). But as diversions increase, especially for agriculture, and as in-stream users (e.g. hydroelectric dams) alter flow regimes, wetlands and deltas dry up, water tables and base flows decline, the natural ecology suffers and pollution is concentrated in the limited flow that remains. As a river basin closes, therefore, action must be taken to limit diversions if environmental flows and values are to be protected. What remains is typically diverted by irrigation, and agriculture rather than the environment becomes *the residual user.*

Both agriculture and urban uses contribute directly to pollution of streams and aquifers, sometimes making water unusable for domestic use. Direct agricultural pollution in the USA is said to be $9 billion per year (Bate, 2002). Despite 13 rivers flowing through the city, the degradation of their water due to agricultural and M&I uses has forced Jakarta to tap surface sources 78 km away (McIntosh, 2003); a similar situation is found in Seville because of pesticide and fertilizer residues in the Guadalquivir river; in Chinese cities (Bhatia and Falkenmark, 1993), including Chengdu, where water pollution and silt have forced the closure of two river intakes and the government is investing heavily in watershed rehabilitation (McIntosh, 2003). Irrigation is also responsible for waterlogging and soil salinization as water is diverted to poorly drained low-lying lands within, and at the tail of, irrigation schemes. Other externalities include the mobilization of silt due to catchment changes, which can have devastating impacts on river morphology (famously for the Yellow River), and the mobilization of toxic elements from the soil by leaching. Drainage of the Plain of Reeds in the Mekong delta, for example, releases acidity in waterways, while selenium in California has provoked high mortality of wild fowl in receiving wetlands (Wichelns, 2003).

With regard to groundwater, springs and wetlands fed by groundwater dry up in response to falling water tables (e.g. Azraq aquifer in Jordan) and base flows in rivers decline; falling water yields and water tables lead to higher pumping costs and to the expropriation of poorer farmers and others unable to afford ever-deeper wells (Kendy *et al.*, 2003 for China): falling water tables also aggravate salinity intrusion in coastal aquifers; especially in urban areas, land subsidence reduces aquifer storage and adversely impacts on infrastructure (Nair, 1991); and declining quality due to direct agricultural pollution compounds that from domestic use, industry and landfills (Sampat, 2000).

Environmentalists have vested high hopes in pricing mechanisms as a means of reducing excessive abstraction of water from ecosystems and of decreasing environmental degradation (de Moor and Calami, 1997; Avis *et al.*, 2000). Hodge and Adams (1997) argue that 'the price [of water] could be raised until the level of demand was consistent with the environmental constraints on supply'. Nevertheless, though there is an enormous amount of literature on valuing the environment, there has been limited work on how these values can be incorporated in irrigation pricing and few practical examples of where this has been attempted. As in the case of opportunity cost pricing (previous section), there appears to be little agreement as to how this should be done, and not much hope that farmers would have much understanding of why they should pay such costs. The discussion in this subsection is therefore relatively brief, reflecting as it does the limited evidence in the literature.

Environmental Pricing Mechanisms

The user-pays and polluter-pays principles embody the idea that quantity and quality externalities should be reflected in the price paid by water users as an incentive to reduce adverse environmental impacts and the emission of pollutants. These principles are much more forcefully applied in M&I (given the relative simplicity of volumetric charging and point-source pollution control) than in agriculture, given the problems of volumetric control in irrigation and the intractability of controlling and monitoring diffuse pollution from fertilizers and pesticides (UNEP, 2000).

The EU's Water Framework Directive goes some way in the direction of introducing environmental pricing in agriculture when it states that water charges should 'act as an incentive for the sustainable use of water resources and to recover the costs of water services by economic sector' (EU, 2000b) rather than be adopted for allocation purposes. Nevertheless, both full cost recovery and internalization of environmental externalities are widely seen as ambitious objectives and are, in many cases, impracticable. Modelling, for instance, suggests that much of Mediterranean irrigated agriculture would be jeopardized by strict application of the Directive (Berbel *et al.*, 2005). Mechanisms that have been suggested for irrigation pricing include both negative and positive incentives:

- *Resource charges.* Imposing a resource charge on irrigation equivalent to net externality costs has been suggested to limit diversions and protect the environment. Such charges, in principle, would be imposed on the scheme and passed down to the farmer as a component of the irrigation charge. In practice, however, charging even for recurrent O&M is difficult (as shown earlier) and resource charges have seldom been more than a small administrative fee aiming to recover the costs of resource management (in China, the UK, Spain, Peru, etc.). As far as is known, they have never been high enough to impact on irrigation diversions. Groundwater abstraction fees could, in theory, also be levied on a volumetric basis to limit abstractions to recharge or to some other defined sustainable level. In practice, however, they degenerate into a flat tax, and collection of volumetric charges remains an insurmountable issue, at least in developing countries (Albiac *et al.*, 2006).
- *Pollution charges.* Pollution charges are an incentive for reducing water use and pollutant discharge, though few countries have applied them in irrigation. Denmark is an exception where farmers are subject to the 1994 'Green Tax Reform' that imposes a water rate of €0.55/m^3 of raw water extracted. Further environmental fees are likely given concerns over pesticide contamination of groundwater. Green taxes also exist in Sweden, the UK, the Netherlands, Germany and Croatia (Berbel *et al.*, Chapter 13, this volume; Wright and Mallia, 2003). In France, farmers pay pollution fees for water used in cattle husbandry, but not in crop production. Income from such charges generally goes to the government budget rather than being used to resolve pollution issues, and are seldom high enough to alter behaviour significantly (Young, 1994).
- *Treatment or remediation charges.* Pollution charges may be more acceptable to farmers if used for remedial works within the scheme or in irrigation more widely – thus 'internalizing externalities' – for instance, to help resolve waterlogging, salinity and other problems that impact on scheme production. In South Australia, the government covers the costs of salinity management caused by irrigation projects constructed before 1988, but environmental externalities are charged for all subsequent projects in a two-part price structure. The environmental part of the charge is used to cover the cost of renovation or construction of infrastructure needed to reduce water quality-related externalities (Easter and Liu, 2005).

- *Taxes and rebates.* Rather than specific charges, pollution abatement programmes are more generally met through general taxes. These may, however, be limited to taxes on water users, introducing a degree of cross-subsidization, with the money collected used to treat the wastewater generated not only by the user but also by other dischargers, be they cities, cattle farmers or industries (as in the Basin Agencies in France). In Korea, in some upper catchments, pesticide and fertilizer use has been prohibited with 25% of the funds generated from domestic consumers along the river used as 'income compensation' for upstream farmers who suffer financial loss due to these environmental regulations (Min, 2004). Rather than being taxed, farmers may receive a tax rebate. In western Canada, for instance, rural municipalities have used the municipal tax system as a tool for encouraging specific behaviour by producers. They offered rebates to landowners who implement environmental practices on their land (e.g. grazing land) (Fairley, 1997).
- *Subsidies.* 'Delinking' farm subsidies from direct production payments under the EU reforms (Berbel *et al.*, Chapter 13, this volume) is a major attempt to build on existing programmes that have 'paid' farmers to adopt environmentally sustainable practices. Comparable payments are made directly to farmers in Switzerland who participate in three main ecological programmes: integrated production, organic farming and ecological compensation (extensive use of meadows). By 1996, 60% of agricultural area in Switzerland was farmed based on integrated production methods and 5% of the area met organic farming standards. The loss of income is said to be less than if the same effect had to be met through product price increases (Pfefferli and Zimmermann, 1997). In Germany, revenue from water taxes is often used to compensate farmers for restrictions on fertilizer use in vulnerable areas. This idea is also behind the wave of payments for 'environmental services', at the catchment level, for example.
- *Pollution permits.* Pollution permits for nitrogen or another pollutant are akin to quotas for water use. Restrictions on farm animal numbers are used in Europe as a proxy for pollution permits, e.g. in the Netherlands where the primary objective has been to limit groundwater contamination from pig and other intensive operations. As in the case of water quotas, 'permissions to pollute' are often more easily administered and have less implication in terms of welfare losses than a comparable tax on nitrogen utilization or on water use (Martínez and Albiac, 2004, 2006). Effluent permits can also, in principle, be made tradable although this is rare in agriculture. A programme in California with regard to selenium has been successful (Young and Karkoski, 2000) and, although comparable trading regimes have yet to be applied to irrigation or farming in Europe, they are being increasingly adopted in other sectors.

Water Pricing as an Environmental Instrument

Several conclusions can be drawn from this short review. Price incentives for the preservation and restoration of environmental sustainability and water quality have mostly been adopted in the non-agricultural sectors and generally in developed countries. While there have been major programmes that aim, for instance, to restore wetlands or tackle waterlogging and salinization in developing countries, these have almost invariably been funded by government and donors and pricing has seldom, if ever, been significant in controlling these ill-effects. With respect to nutrients and pesticide pollution, their diffuse nature makes them very difficult to measure and control, even in developed countries.

There are a variety of potential pricing schemes ranging from the straightforward application of the user-pays and polluter-pays principles, through partial or full cross-subsidizing by other water users, to full state subsidies. Implementation of the user-pays principle is constrained by all the issues related to irrigation charges discussed in earlier subsections, though any charge that limits water use should have some positive environmental impact. However, the feasibility of major additional environmental charges must be doubted. With regard to pollution, potential interventions are numerous although again problematic in developing countries. They vary from individual prevention incentives (stop the polluting activity) to individual remediation (do it better: use organic farming, extensive pastures, keep cattle sludge in farm reservoirs), to individual treatment (clean up your mess before releasing it), to collective treatment (state infrastructure funded by taxes on water users or the public).

Experience in developing countries suggests that negative incentives, though often feasible in the domestic and industrial sectors (where costs can be internalized within utilities and industrial firms), are often replaced by positive incentives in the agriculture sector whereby the polluter is subsidized to improve his environmental management: subsidies address either the cost of doing so, or the foregone benefits from abandoning polluting (but productive) practices. Payment for watershed services, again, is a good example of a positive incentive. Likewise, Varela-Ortega (Chapter 14, this volume) showed that among the various policies implemented to limit over-abstraction of groundwater in the Tablas de Daimiel, Spain, only the full compensation of farmers' foregone benefits proved to be successful (in contrast, compulsory quotas were not). Agriculture is in any case heavily subsidized and it makes sense to redirect subsidies away from incentives that tend to increase pollution (e.g. by rewarding higher yields) to those that promote good environmental management. Delinking of subsidy payments under the CAP is undoubtedly the most important and dramatic example of this trend, with the major underlying objective of promoting environmentally sustainable agriculture throughout the union (Berbel *et al.*, Chapter 13, this volume).

In conclusion, as in the case of opportunity cost pricing, there are severe practical difficulties of estimation, implementation and enforcement on the one hand, and of persuading farmers that they should pay for environmental externalities that – in their view – have only a tenuous connection with their activities on the other (World Bank, 2003a,b). Direct treatment measures can perhaps be 'internalized' but, with little agreement on how broader externalities can be valued, there is little prospect that farmers will be persuaded to pay for what they do not regard as their responsibility, and little prospect that politicians will impose such burdens under conditions of rising income inequalities and farmer unrest.

SYNTHESIS: CONTEXTUALIZING THE DEBATE AND SUGGESTING ANSWERS

An Emerging Storyline

This chapter has reviewed the different objectives of water pricing policies in agriculture. The overall picture that emerges is that of a gap between stated objectives and expected benefits on the one hand, and the actual and foreseeable impact of these policies on the other. Too often, stated objectives are based on analogy with the water supply and energy sectors. However, such an extrapolation can be very misleading given the particular characteristics of the irrigation sector.

An assumed correlation between low charges and low efficiency in surface irrigation has fuelled the chief narrative on water pricing. From this alleged causal link, it is inferred that raising prices would generate more careful practices and efficiency gains. Although generally valid for water supply and energy, this cannot be systematically assumed in irrigation. Reasons, in part, reflect the hydrological context and the characteristics of irrigation design and performance. In practice, most schemes and farmers are 'water takers', using whatever water is supplied to them, with the causes of uneven and unpredictable supply typically lying upstream of the scheme. Even when scheme supplies can be assured, it is deficiencies in scheme management that result in uncertainties and inequities at the farm gate rather than any price (dis)incentive. Farmers' responsiveness to price requires that charges are volumetric. Farmers have control over the quantity of water they take and the price is sufficiently high to correspond to the elastic portion of the demand curve. This combination of circumstances is, unfortunately, exceedingly rare.

Empirical evidence suggests that under conditions of scarcity: (i) farmers use water more efficiently, in particular, through conjunctive use; (ii) basin-level efficiency rises considerably; and (iii) surface water use is almost invariably regulated – in a more or less controlled manner – by rationing and quotas. The prevalence of quotas can be explained by their effectiveness in balancing supply and demand in response to variable supplies, while incurring far less loss in income than with price-based regulation; their relative transparency and equity; and the low infrastructural and transactions costs involved in their establishment. In a few modern systems, users have some latitude to use water above (or below) their quotas and in these cases water charges can be effective in influencing use at the margin. Markets at local level can also help balance supply and demand. Wider markets in quotas (water rights) can also promote high-value use, but have demanding technical and institutional preconditions and are seldom feasible in practice.

A more profound change than any of these has, however, been the spread of tube wells. By allowing farmer control, tube wells offset the risks, inadequacies and uncertainties not only of rainfall, but also of surface supply. Not only does this approximate to irrigation on demand – the holy grail of advocates of modernization and water pricing – but it also detracts from the need to deliver water on demand in surface systems since groundwater irrigation can (and in practice does) support a large part of the crop diversification and high-value farming that can be realistically envisaged. Ironically, and in contrast to surface supplies, it is the transaction costs of enforcing quotas that is prohibitive in the case of groundwater, and it is the long-term degradation of the resource that represents the major challenge in groundwater management.

What then is the role of irrigation water charges in surface irrigation? Figure 2.9 repeats the objectives suggested in Fig. 2.1, together with a summary of the constraints on achieving these objectives that have emerged in this chapter. They are briefly discussed below.

Economic theory suggests that, if the necessary preconditions are met, marginal cost pricing provides the signals to the farmer that optimizes his use of water. In contrast to the water supply and energy sectors, this chapter has suggested that marginal costs in irrigation should generally exclude initial capital costs. If so, direct marginal costs as a minimum comprise recurrent O&M, replacement and modernization costs. In principle, they should also reflect opportunity values in other uses and incorporate externality costs. The estimation and implementation of these measures is, however, fraught with difficulties. Moreover, marginal cost pricing is dependent on volumetric control, and in practice, pricing of water falls well short of full on-demand pricing.

Recovery of O&M costs is the most compelling reason for levying irrigation charges, notably if public funds are insufficient to operate and sustain the infrastructure. Cost recovery has understandably been the central objective of project design and national policies, and has become more pressing as irrigated areas have expanded and fiscal constraints have developed in many countries. Recovering just O&M costs has, however, proven much harder than expected and in the great majority of cases farmers are charged no more than a share of these costs. Moreover, defaulting is pervasive, especially in systems where supply is unpredictable and uneven and where staff has no incentives to enforce recovery. In a few cases, a share of capital cost is also recovered in addition to O&M, and/or farmers pay a management or a resource fee, or

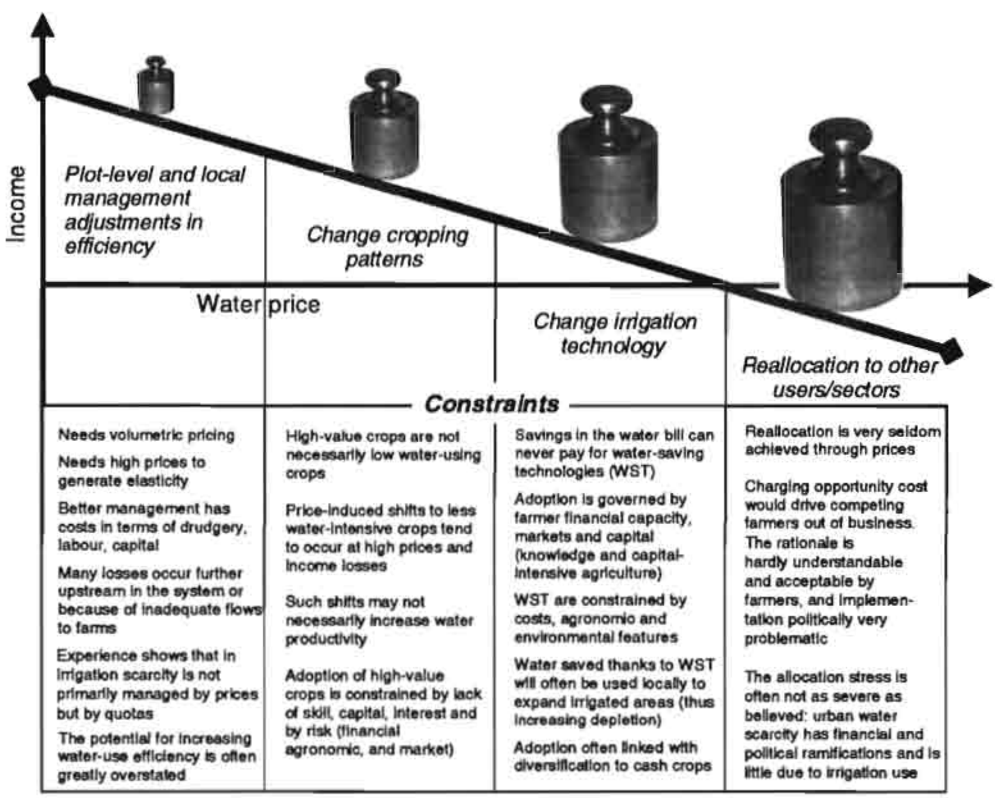

Fig. 2.9. Summary of constraints to using prices as an economic tool.

an environmental tax, but these seldom total more than about 10–25% of O&M costs. Charging for capital costs in new projects has the potential to ensure cost-effectiveness and users' interest and to crowd out politically motivated projects, but this is as yet seldom applied.

A wide array of benefits beyond sustaining the infrastructure is often anticipated for water charges, even when not warranted by the level or structure of the charge. This may reflect an improper understanding of charging mechanisms or be a means to justify the proposed policies. Chief among these are the view that raising prices will contribute to water conservation though, as discussed above, this is seldom valid. Charges may, however, have potential for eliciting longer-term shifts in crops and technology. Farm models often suggest that price-induced shifts and attendant water savings are possible but, as in the case of reducing water use, crop and technology choices are usually determined by other factors. Poor farmers irrigate low-value crops for many reasons (risk, capital, skill, markets, water supply, etc.) and, in particular, the risks to them of shifting to higher-value crops are considerable. Moreover, high-value cropping is inherently limited by market conditions and surface irrigators must compete with those having access to tube wells. If alternative crops or possible gains in efficiency are limited, farmers with extensive agriculture and low revenues will often revert to rain-fed farming, rent or sell out their farm, or just keep land fallowed, unless subsidies help them invest and intensify their practices. In practice, subsidies are often made available for such farmers.

High-value cropping often goes together with modern technologies, taking advantage of a host of positive factors beyond water savings, including higher yields, better product quality, fertigation, reduced labour, etc. Water costs are seldom the only or even the primary motivation for such shifts. In addition, water-saving technologies reduce return flows, but impact little on the fraction depleted by evaporation and transpiration; and in some cases, the water saved is used to expand the cultivated area, thus increasing depletion. In the latter case, promoting micro-irrigation can be counterproductive since the fraction consumed by crops increases at the expense of aquifer recharge, return flows and/or reallocation to other uses.

Low charges are also commonly taken to indicate a misallocation of resources that can be rectified by charging an opportunity cost. In practice, not only has opportunity cost pricing seldom, if ever, been attempted, but the very existence of an 'allocation gap' can be disputed. Priority is invariably given to M&I during a drought; over the longer term, most countries transfer water out of agriculture by stealth or administrative action; and there is little to indicate that urban and economic growth are eventually seriously constrained by water that is locked up in irrigation uses (except for some situations in the USA). Urban water and sanitation deficiencies are overwhelmingly due to political priorities and financial constraints rather than to lack of water. Moreover, opportunity cost is location-specific and, once effective demand in competing M&I uses is satisfied, opportunity cost falls off drastically. Opportunity cost pricing would drive those few farmers facing urban competition out of business, while most others would continue to obtain water at a much lower price. Markets are an attractive alternative, but the technical and institutional preconditions are daunting. Perhaps the most promising approach is negotiation on a case-by-case basis since, though government regulation is still required, compensation can be assured to those deprived in an open and transparent manner and in ways adapted to the particular conditions. Planning compensation mechanisms for temporary transfers *in anticipation* of drought will help avoid conflicts and turmoil when these occur.

Similar practical objections face the estimation and implementation of environmental pricing. Any charge that limits water use is likely to have some positive environmental impact but, given the constraints discussed above, imposing additional environmental charges on water use may not be feasible. It is therefore, perhaps, no surprise that while both the user-pays and the polluter-pays principles claim to internalize externalities by negative incentives at the source, in practice these externalities tend to be internalized at the system, basin or national level, through cross-subsidization from other users or the general taxpayers. Users get paid to control water losses or pollution, or even for the foregone revenue of not creating the externality, rather than being charged for the externality.

In conclusion, given the struggle to recover O&M and other recurrent costs in large-scale public irrigation, it is unlikely that water charges at levels much above O&M costs will ever become feasible. Participatory management, co-management, and autonomy can strengthen incentives for meeting the financial costs of supply, but irrigation charges are unlikely to have major impact on cropping patterns, technology or allocation between sectors; objections to opportunity and externality cost pricing will remain and, where farmers are given a say in the determination of charges, these are unlikely to be set much over O&M costs. In sum, whether management remains under state agencies or is shifted to farmer organizations, O&M will remain the reference 'peg'. Pricing will be sometimes effective in groundwater use and as a mechanism to regulate use beyond the quota, wherever individual volumetric pricing is possible. Bulk allocation with innovative incentives may also, in the future, help achieve efficiency gains, as experimentation in China suggests. In other words, the consensus of the mid-1980s (see Molle and Berkoff, Chapter 1, this volume) still largely holds and much of the discussion on pricing instruments in public surface irrigation, and the hopes vested in them over the last two decades have been an unhelpful distraction. Physical sustainability and proper management remain compelling objectives and finding ways to strengthen financial autonomy and the reliability of supply remains paramount.

Cost Sharing with Power Sharing

Analysts in the 1980s appreciated that irrigation pricing policies had limited potential for promoting conservation and reallocation. Rather, they emphasized that farmer payments should be part of a wider realignment of roles and responsibilities in irrigation management. Irrigation charges could be the 'glue' of contractual arrangements between higher- and lower-level entities, down to the WUA. Autonomy at each level would create 'downward accountability', with payment made from the lower to the higher level in return for a negotiated service (defined as a certain pattern of supply). Each level would maintain and operate the infrastructure under its jurisdiction while contributing its share of system O&M costs. Under such conditions, user charges could help: (i) enhance availability of funds for O&M; (ii) strengthen accountability of managers to water users; (iii) increase involvement of water users in O&M; and (iv) improve the quality of investment decisions (Small, 1990).

This model has been constantly rediscovered and is deeply interwoven with strands of participatory management and turnover (Molle and Berkoff, Chapter 1, this volume). The nature and scale of what is transferred have varied widely. In some cases (Thailand, Sri Lanka, Pakistan and India) participation was based on tertiary canal user groups that were to federate. In practice, however, most were given too little power and fee collection has often failed (Merrey, 1996). Limitations in hydraulic infrastructure (Lankford and Gowing, 1997; Facon, 2002) have also been a constraint that often revealed the mistaken conception – perhaps inherited from domestic water supply – that it is possible to define a service in irrigation as 'simply' as in the domestic sector. In more successful cases (Mexico, Turkey and Argentina) O&M of the main system are retained by the public agency but WUAs are established at block and tertiary levels. In yet other cases, often smaller schemes with fewer richer farmers, the scheme has been entrusted wholly to farmers, with the state retaining a supervisory role (e.g. in Peru: Vos, 2002; Colombia: Vermillion and Garcés-Restrepo, 1998; Japan: Sarker and Itoh, 2001; and Catalonia: Fernandez-Urrutia, 1998).

The responsibilities transferred have also varied. WUAs are generally responsible for O&M within their area of jurisdiction, but some are only responsible for water management at higher levels. Their role in planning may be symbolic (allocations decided by the agency based on water availability), more proactive (with joint decisions on allocations to different areas) or even entail total responsibility. Financial contributions also differ (Spencer and Subramanian, 1997). Allotments to WUAs can be decided by the agency alone or jointly with WUAs; enforcement and monitoring of service can be more or less strict and with varied recourse by users; WUAs may trade allocations (as in Mexico); and in some cases charges levied also fund part of the agency's costs, while in others the agencies are subsidized by the state. Variations are inevitable and desirable and it is difficult to generalize. Nevertheless, empirical evidence collected over the last 20 years or so suggests a number of observations on the basic pattern.

The model is by and large valid but has exceptions

There is a strong relationship between the power devolved to farmers and their financial contribution. Where farmers are confined to tertiary-level activities, success has often been poor. When given management responsibilities besides O&M, they have often been able to take more substantive decisions, e.g. hiring field staff and deciding how to spend funds on maintenance (Mali: Aw and Diemer, 2005; northern Peru:

Vos, 2002; Argentina, etc). Where they are also contributing to the costs of running the public agency, their powers also tend to increase (Peru, Colombia), though this is not always the case (Vietnam: Fontenelle *et al.*, Chapter 7, this volume; Philippines). A farmer's financial contribution to O&M is no doubt necessary if farmers are to be given significant managerial powers, but is neither necessary nor sufficient for effective overall management and maintenance. In some cases (e.g. Morocco, Tunisia and Iran) farmers cover most or all of O&M costs and receive a reasonable service without strict accountability mechanisms. In contrast, the NIA in the Philippines illustrates the dangers of overestimating the capacity of supposedly autonomous agencies to ward off political interference. Moreover, NIA has responded to inadequate funds not by augmenting revenues, but rather by reducing costs and servicing only parts of the system (Kikuchi *et al.*, 2001; Oorthuizen, 2003). In the case of Taiwan (Moore, 1989; Lam, 1996) effective management by officials and farmers is achieved though user charges have long lost their significance, since the state re-established O&M funding in the early 1990s. Accountability is not supported by bureaucratic rules, but is embedded in social relationships and social control.

Narrow functionalism

Small and Carruthers (1991) recognized 'linkages existing between structural and managerial aspects on the one hand, with financial approaches on the other' (Small, 1990) but retained a functionalist view of agency–farmers arrangements: that charging linked to accountability could ensure transparent and effective cross-compliance and end the 'degradation vicious circle'. They have been criticized for overlooking the wider social and political dimensions that affect the level and utilization of charges independently of performance (Oorthuizen and Kloezen, 1995). Water charges are elements of negotiation in power struggles between farmers and their associations, and between WUAs and the agency or state. While these negotiations are bounded by hard-nosed realities, such as farmer financial capacity and the actual cost of supplying water (Lee, 2000), they also reflect competing interests, differing perceptions, the political clout and bargaining power of the different parties, and the various levels of accountability and dependency between them. They are permeated by the distribution of power within and across these groups (see case studies for the Philippines: Oorthuizen, 2003; Peru: Vos, 2002; Vietnam: Fontenelle *et al.*, Chapter 7, this volume; Taiwan, South-Korea, Japan: Sarker and Itoh, 2001; Tanaka and Sato, 2003). In other words, while 'money talks' and creates some dependency, accountability was shaped predominantly by inter-group and interpersonal relationships expressed in such factors as friendship, kinship, gifts, business partnerships, bribes, threats of violence, patronage, debts, asymmetries of power and information, and political allegiance. This warns us against simplified views of human organization and may help anticipate dysfunctions.

Second-generation problems

Encouraging financial and managerial autonomy of irrigation blocks or schemes coincides with the retreat of public agencies to higher levels of management. Autonomy has, in general, been successful in divesting the state of financial burdens but, according to many observers, has been largely neutral in terms of irrigation efficiency, water reliability and water productivity (Meinzen-Dick *et al.*, 1994; Vermillion, 1997). This in part reflects unrealistic expectations given that irrigation has always been more efficient than is commonly supposed and that farmers and managers have in any case adjusted to prevailing conditions. But it also reflects 'second-generation problems' that have gradually surfaced and have adversely affected performance including: the failure to adjust charges leading to deferred maintenance; the lack of data collection and analysis; imprecise rules governing asset ownership and management; and an unclear definition of water rights (Svendsen *et al.*, 1997; Vermillion and Garcés-Restrepo, 1998; Vermillion and Sagardoy, 1999). Among these, the most important problem has probably been the first: a short-term unwillingness to adjust fees upwards, to the detriment of long-term sustainability.

Opening up the model

The focus on financial autonomy has sometimes been superseded by more general participatory policies that emphasize reducing agency costs, or social engineering objectives. Nevertheless, there has also been renewed interest in the potential role of private operators and public–private partnerships (Frederiksen and Vissia, 1998) and in reviewing the whole spectrum of 'water service entities' from private to self-governing bodies (Lee, 2000; ICID, 2004; Frederiksen, 2005). Préfol *et al.* (2006) have pointed to the need for 'professional third parties' between farmers and government, irrespective of whether these are public or private. The crucial questions are accountability and incentive structures (Merrey, 1996). Promotion of volumetric management and bulk allocation is no doubt essential, but cannot ensure that incentives reach the individual farmer. Greater attention thus needs to be given to strengthening incentives at the tertiary and block levels. Interesting examples include the Philippines, where commissions are paid to WUAs that are successful in recovering charges (Ofrecio, 2005), and China where managers and subcontractors have both been given performance incentives (Lohmar *et al.*, Chapter 12, this volume; Li, 2006).

An alternative to the fiscal autonomy model patterned on utilities (O'Mara, 1990) takes up the idea of water delivery as 'co-production' (Lam, 1996; Ostrom, 1996). Under a 'co-production' approach, farmers and others participate in the production of public goods, in contrast to a 'service' approach under which they are merely passive 'clients'. It is argued that involving users at higher levels strengthens accountability and ensures that participants are aware of management constraints, existing inequities and actual available resources, the aim being to shift their role from that of 'selfish complainers' to co-managers of the whole system. According to this, the state must still inevitably retain supervisory powers, especially over financial management and maintenance standards, and in this regard it is lack of effective government capacity rather than lack of farmer and 'client' awareness that remains the major obstacle to creating self-sufficient entities (Frederiksen, 2005).

Perspectives for the Future

This review suggests that water charges can only achieve the objectives assigned to pricing as an economic tool (Fig. 2.1) in very special circumstances. But there is a continuum from projects with excess water and poor management at one extreme to those under volumetric management and – at the limit – irrigation on demand, at the other. Scarcity will continue to be dealt with by rationing in the large majority of cases, but price incentives can sometimes promote conservation and in a few cases regulate water use at the margin. The way forward is thus to expand the area served by volumetric management so as to facilitate extension of quota-cum-price regulation (Fig. 2.10), recognizing that this will be a slow process, given the structural and institutional changes needed, and that it may not always be appropriate or cost-effective to do so.

Such changes cannot be driven primarily by modernization investment or by social engineering that is inconsistent with the broader context. Effective financial mechanisms are predicated on the emergence of autonomous entities that vary with context but which entail genuine user empowerment. It should be recognized, however, that irrigation efficiency and water productivity are more about changes in irrigation management than changes in farmer behaviour;

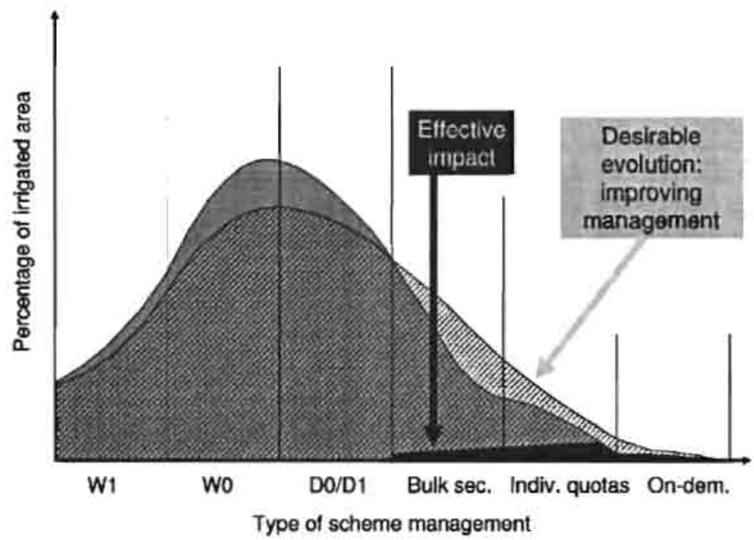

Fig. 2.10. Management types and desirable shifts.

more about designing cross-compliance arrangements and financial autonomy than simply establishing WUAs; (iii) and more about defining positive incentives to managers than introducing negative incentives to end-users.

Policies based on negative incentives alone are unlikely to have great success. The user-pays and polluter-pays principles thus need to be complemented by positive incentives. It may be more efficient (as well as more equitable) to buy out wells than to decree extraction quotas; to pay upstream farmers for not polluting water or deforesting watersheds than to tax these activities; and to negotiate compensation arrangements for water transfers than to expropriate them. The limited capacity of the state, and the political sensitivity of actions to modify behaviour that result in significant loss of income are major reasons why water and pollution charges have, in practice, been so difficult to introduce and enforce. Policy packages should ideally combine 'positive' and 'negative' instruments in ways that are adapted to circumstance (Bazza and Ahmad, 2002; Chohin-Kuper *et al.*, 2002; World Bank, 2005a). Since many factors other than water price so often determine water use, water policies must also be designed with due consideration to policies in other sectors.

Since individual metering is so problematic in surface irrigation, priority must be given to bulk allocation, all the more because it is consistent with strengthening co-management institutions and arrangements. Since financial incentives seldom impact directly on individual users, emphasis should normally be placed on management incentives (whether to private or community operators), while ensuring financial transparency. This is consistent with the fact that efficient management of supply is easier at block level than at individual farm level. There may be potential for trading in bulk allocations within the system, provided this is ultimately decided by stakeholders and can be effectively regulated, but intersector trading is likely to be feasible in only a few exceptional circumstances.

It must be recognized that much, if not most, surface irrigation, especially in countries with large irrigation sectors, will continue to be devoted to cereals and other relatively low-value crops. No doubt an increasing number of farmers will intensify and diversify output, often based on tube wells, but this is limited by market constraints and most farmers in surface irrigation are likely to remain relatively poor, at least as long as prices remain at current levels and until such time as economic development draws population off the land sufficiently to allow significant farm consolidation. This suggests caution in implementing expensive modernization and similar programmes that may not be justified by the production benefits. It also suggests the necessity of taking account of the deep social and political concerns raised by poor farmers. As stressed by Garrido (2002): '[N]o pricing policy will ever make progress if irrigators' benefits are severely compromised as a result of its full implementation. In the short and medium term, irrigation farms' economic survival is essential.' Economic policies pursuing efficiency will thus inevitably have to compromise with equity and social concerns and take into consideration the diversity of farming systems and regions.

Overemphasis on 'getting the prices right' (Svendsen and Rosegrant, 1994) has distracted attention from the nature of most of the irrigation in developing countries. Very few schemes can distribute water in a way approaching the on-demand supply model that typifies urban tap water. Farmers cannot be blamed for losses occurring upstream of their farm; nor can they be blamed for much of the waste arising out of a pattern of supply that is largely independent of their will. The importance of the old unglamorous issue of *managing supply* will thus continue to override that of *managing demand*. No doubt this will gradually change as irrigation moves along the continuum suggested in Fig. 2.10. But even then, developed countries' experience suggests that most efficiency gains are due to the numerous other factors involved in the shift from pragmatic to volumetric management; and that the task left to pricing even in the long term may well be far more modest than often assumed.

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5 Thailand's 'Free Water': Rationale for a Water Charge and Policy Shifts*

F. Molle

Introduction

Despite the success claimed for the irrigation sector in contributing to falling food prices, food security and raising farm income, irrigation has, in the last two decades, elicited growing frustration in the community of aid agencies and development banks. A major reason for such sentiment is the low financial sustainability of the sector, which incurs recurrent rehabilitation expenditure and subsidies to operation and maintenance (O&M) that add to the large initial investment costs. A second reason is that agriculture accounts for 70% of the use of water and, despite growing shortages, is seen to be bedevilled by very low levels of efficiency (the water effectively used is only a small fraction of the water diverted) that seem unacceptable in a time of growing needs in other sectors. In addition, farmers often apply large quantities of water to irrigate crops that have both high water requirements and a low return (typically, rice in Asia).

These problems of perceived low efficiency, poor management and financial unsustainability have been addressed by a wide range of actions that include rehabilitation, modernization, improved technical management, participatory management, turnover and collection of water charges. The limited benefits obtained have spurred many proposals to tackle these problems with some economic tools and incentives, particularly in the aftermath of the Hague and Dublin meetings (Rogers *et al.*, 1997).

In Thailand, water is supplied to agriculture free of charge: water is best seen as a gift, traditionally linked to the good will or power of the absolute king, who mediates its supply from supernatural forces. *Chonlaprathan*, the Thai word for irrigation, embodies a notion of the royal gift. The *Loy Krathong* festival, in November, when offerings are put afloat on the waterways of the kingdom to thank the water spirits for the life that water brings, epitomizes the relationship between people and water. However, proposals for water pricing in the country can be found as early as 1903, in the *General Report on Irrigation and Drainage in the Lower Menam (Chao Phraya) Valley*, submitted to the Government of Siam by Van der Heide (1903), a Dutch engineer in charge of the Department of Canals:

> A water tax could be levied, in a manner similar to the paddy land tax, over the whole area at present cultivated and the future extension of this area, as far as the fields are benefited by the [irrigation] system . . . water rates could in general be assessed in some proportion to the quantity of water utilized, and would most probably be a suitable taxation for dry season crops and garden cultivation.

The logic for pricing water may have, at that time, been borrowed from practices in Java, India or other Asian countries under colonial rule. Likewise, in the post-World War II period when the International Bank for Reconstruction and Development funded the development of infrastructures in the Chao Phraya delta, the consultant in charge of the study saw no difference between irrigation supply and railways or electricity and stated that it would 'not be a misuse of language or an exaggeration to describe the position [of Thailand] as extraordinary.... The Irrigation Department is thus unique among the commercial departments of the Government in Thailand in deriving no revenue from its services and unique or nearly so in this respect, throughout the world' (IBRD, 1950).[1] Although, at the time, the Thai government had shown willingness to establish fees once the scheme would be completed and proper supply ensured to users (IBRD, 1950), the idea seems to have then vanished and only recently come to the fore. In the aftermath of the 1997 financial crisis, reform of the agriculture and water sectors was encouraged by both the World Bank and the Asian Development Bank (ADB), and the latter supported the definition of an ambitious plan aimed at introducing river basin management, service agreements between the Royal Irrigation Department (RID) and users, cost recovery dubbed as 'cost-sharing', and legal dispositions around a Water Law. This policy remained a dead letter for a set of reasons that cannot be easily untangled, but which includes resistance from line agencies, weak political support and the over-optimistic and often unrealistic nature of many of the proposals. Despite the setting of a policy matrix that defined commitment to successive milestones to be achieved, the process lost momentum before being eventually discontinued by the Thaksin administration.

In this chapter, I first examine the relevance of the arguments for establishing water charges in the particular context of Thailand, and most particularly that of the Chao Phraya delta, the rice bowl of the country (Molle and Srijantr, 2003). In the first section, I address successively the role of pricing as: (i) a means to signal to users the economic value of water and hence regulate its use and avoid wastage; (ii) an instrument to reallocate water to crops with higher water productivity or to non-agriculture sectors; and (iii) a cost recovery mechanism. In the second section, I briefly examine reforms that failed in the past, and attempt to draw conclusions on both the potential charging for water and the way a policy reform process should unfold. Although unsuccessful, these attempts at reforming the water sector provide useful lessons on the constraints commonly faced by water pricing policies, particularly when they fail to fully appreciate the context in which they are to operate.

Before turning to these points, it is useful to single out a few specific features of the Chao Phraya delta, on which the analysis will focus. Agriculture in the delta traditionally distinguishes between the wet season (where rain is abundant, sometimes in excess, and irrigation merely a complement) and the dry season (when irrigation is a prerequisite to agriculture). The hydrology of the delta is very complex, since it includes numerous side flows and return flows, canals serving for both supply and drainage, generalized use of pumps, predominance of paddy with common plot-to-plot systems of supply, vulnerability to flooding, use of waterways for navigation, domestic supply, dilution of pollution load, etc. This defines a context with numerous uses and users where it is difficult to clearly identify both the sources of supply and the uses, and which is therefore little amenable to quantitative regulative mechanisms. Many of these features apply to other Asian deltas, particularly those of the Cauvery, Ganges–Brahmaputra,

[1]The consultant also underlined the value of charging for water in order to limit wastage and to control society's demand for unsound projects: 'Mankind values the things it has to pay for and thinks little of and uses wastefully the things it gets free. Moreover if water is supplied free, farmers who get no water will be unable to see why their neighbours should and the Government will be embarrassed by pressure to carry out schemes regardless of whether they are sound or not.'

Irrawaddi and Mekong rivers. On the other hand, the delta includes Bangkok and enjoys good transportation networks and rather efficient linkages to urban and export markets.

Water Pricing and Its Potential Roles in Thai Irrigated Agriculture

Dealing with unacceptable water wastage?

The statement that water is wasted when it is free or underpriced probably appears in one form or another in all papers and reports that address the issue of water pricing (see Molle and Berkoff, Chapter 2, this volume). This simple axiom has been disseminated widely by analysts like Sandra Postel (1992), who observes that 'water is consistently undervalued, and as a result is chronically overused', by development banks and agencies (e.g. World Bank, 1993; ADB, 2000), as well as by many academics. In Thailand, an endless number of observers[2] have taken it for granted, notably TDRI (1990) and Christensen and Boon-Long (1994), who posit that 'since water is not appropriately priced, it is used inefficiently, and consumers have no incentive to economize'. Several reasons, related to both theoretical assumptions and constraints to implementation, showing that such statement may be misleading are reviewed here.

That rising water fees may be conducive to water saving is shown by numerous experiences in the domestic and industrial water sectors (Gibbons, 1986; Dinar and Subramanian, 1997; Dinar, 2000). Since individual meters can be easily installed on pressurized pipe networks, volumetric charging is practical and users' behaviour is generally affected by rising charges although, beyond a certain point, the elasticity of water demand falls drastically. The facts that *volumetric* charging is a prerequisite and that it is not feasible in the short run in most large-scale irrigation schemes of Asia are well recognized in the literature. Yet, in Thailand, where most of the hydraulic structures are rather crude, this evidence is generally glossed over and the potential benefits of volumetric charging are often assumed implicitly for pricing *in general*, as illustrated by the various statements collected in footnote 3.

Since volumetric pricing at the individual farm level is unrealistic, 'water wholesaling' in which water is attributed to groups of users, for example, to the farmers who are served by the same lateral canal, appears to be an attractive option. This alternative has the advantage of encouraging farmers to act collectively to achieve reduced demand within the command area of their canal, and shifts on them the burden of solving conflicts and collecting a water charge. However, the effectiveness of such an arrangement rests on the possibility of: (i) defining and registering who the beneficiaries are; (ii) designing a transparent allocation mechanism at basin, project and farm levels; (iii) ensuring water supply to groups in accordance with an agreed service; and (iv) having Water User Groups that are in a position to perform all the tasks entrusted to them. Therefore, the wholesaling of water appears more like an option that would be made possible by a series of critical reforms spanning technical, legal, managerial and political domains, than a measure that can be put forward in a 'non-mature' context. In the case of Thailand, few, if any, of these prerequisites are met.

The policy framework supported by the ADB in the 1999–2001 period (see later section) laid some foundations for establishing 'cost-sharing' and defining 'service agreements' between the RID and users that could amount to a kind of bulk allocation. Attractive in its design, the policy probably much

[2]How popular wisdom emerges can be sensed from the following declarations. An official of the Ministry of Agriculture said: 'Water should be priced in order to increase the efficiency of its use in the farm sector' (*The Nation*, 2000, 21 April); 'Agricultural experts agree that water-pricing measures would help improve efficiency in water use among farmers' (*The Nation*, 1999, 17 February); the Director of the National Water Resources Committee observed: 'In reality water is scarce, and the only mechanism to save water and encourage efficient use is to give it a price' (*The Nation*, 2000, 23 April); etc.

underestimated[3] both the technical difficulties to define and ensure service agreements and the institutional/political transformations required (Molle *et al.*, 2001). Even where bulk allocation was implemented as part of a programme of management transfer (as in Mexico and Turkey), was credited with some success and contributed to a better fee collection and financial situation, there is little evidence that significant water saving in land or water productivity or gains have resulted from these reforms (Murray-Rust and Svendsen, 2001; Samad, 2001).

Even if some kind of volumetric pricing were possible, prices would have to be set at a level high enough to have a bearing on farmers' behaviour. There is, indeed, overwhelming evidence from the literature that tariffs which reflect O&M costs and are economically feasible are in too low a range to have any significant impact on behaviour (Gibbons, 1986; de Fraiture and Perry, Chapter 3, this volume; Ray, Chapter 4, this volume). An average water fee of B(baht)120/rai (one rai = 0.16 ha) as proposed by the ADB policy (H&P and A&E, 2001) would amount to 5–7% of the farmer's net income per rai. While not negligible, such a value would be unlikely to affect behaviour at the margin, assuming – for the sake of demonstration – *volumetric* and individual pricing, saving, say, 30% of water would increase the revenue per rai by only 2%, a value much under the opportunity cost of the additional labour necessary to achieve such water savings at the plot level. It can therefore be safely concluded that the proposed fee, based on area and set at half the estimated O&M costs, would have no impact on water use whatsoever, despite repeated claims to the contrary.

The second issue considered here is whether water is indeed wasted, and whether significant savings could be achieved, through pricing or other means. Recently, the Director-General of the Royal Irrigation Department on a Thai national television channel declared somewhat contritely that water efficiency was very low in Thailand and that this had to be remedied in the face of the water shortages experienced by the country. International agencies (and sometimes, in their footsteps, local officials) commonly report that Thai farmers are *guzzling* water or are showing *water greed* (*The Nation*, n.d.), furthering the general idea that efficiency in large state-run irrigated schemes is often as low as 30% (TDRI, 1990), and sticking to this overall vision without questioning it any further. Yet, research conducted in recent years has shown that water basins tend to 'close' when demand builds up: most of the regulated water in the basin is depleted and little water is eventually 'lost' out of the system *when it has value* (downstream requirements and environmental services taken into account). There has been widespread recognition that focusing on relatively low irrigation efficiency at the on-farm or secondary levels could be totally misleading (Keller *et al.*, 1996; Perry, 1999; Molle, 2004). When analysed at the basin level, closing systems are eventually found to *operate with a high overall efficiency* during the dry season.

In-depth investigations in the Chao Phraya river basin (Molle *et al.*, 2001; Molle, 2004), most particularly in the delta, have shown that users and managers have not been passive when confronted with water scarcity but, on the contrary, have responded to it in many ways. Farmers have developed conjunctive use, dug farm ponds, drilled wells, closed small drains and invested in an impressive pumping capacity to access these sources. Dam managers have come under pressure to avoid dam releases that are in excess of downstream requirements and have improved management. Reuse of water along the basin and within the delta has developed to the point that, in the dry season, only an estimated 12% of the water released by the dams is lost to non-beneficial evaporation or outflow—effectively recycling the 'losses' from excessive water diversions

[3]One of the consultants involved considered that the policy was not optimistic but 'simply stated what, ideally, *ought to be done*, without claiming that it *would* be done'. This, however, implies that proposals are made on a prescriptive and idealized mode without taking into consideration the institutional and political context in which they are supposed to be inserted.

in exactly the way that research elsewhere has found and predicted. Because of the tendency to focus on state-designed policies, all the endogenous adjustments to water scarcity that accompany the closure of a river basin are generally overlooked (Molle, 2004).

Irrespective of whether they pay for water or not, farmers are aware that water is valuable and scarce because they are directly confronted with the consequences of its scarcity, and have made significant investments in pumps, wells and ponds to tackle it. To squander water, farmers should first be in a position to access *more* water than they need, which is contradictory to the situation in the dry season, where cropping intensity is around 60% and where water shortages push farmers to actively look for alternative sources of water.

In the wet season, patterns of water use often differ. In many instances water management is geared towards getting rid or controlling the potential damage, of excess water, rather than saving water. Water use at the farm level may be wasteful, but this only reflects the fact that supply is continuous and abundant (with a zero opportunity cost) and that the water 'wasted' was destined to flow back to the river anyway. Indeed, abundant water can ease management both to farmers and operators so that 'wasting' water may be the economic optimum given its zero opportunity cost.

Finally, stating that water is 'free' misses the point that the majority of farmers have to resort to pumping to access water in the dry season (when saving water is an issue), to offset both the lack of water and the uncertainty in delivery. Because of the costs incurred by these water-lifting operations, there is little likelihood that farmers (80% of farmers in the lower Chao Phraya basin have at least one pump set) will squander water (Bos and Wolters, 1990).

Shortages and crises are not due to a hypothetical low efficiency but to the insufficient control over interannual regulation, water allocation and distribution. The lack of strong technical criteria in managing dams and in allocating water to irrigation, the uncontrolled planting[4] by farmers and the irresistible political pressures to which competition for water gives rise, lead to escalating risk and sporadic shortages. This does not dismiss the fact that efficiency gains are desirable but draws our attention to the inconsistency of the commonly stated relationship between farmers' efficiency and water shortage.

Overall, it emerges that both the empirical and theoretical justifications advanced to support the use of water pricing as a regulatory tool for saving water do not hold in the present case. On the one hand, water is not squandered as commonly assumed (adjustments to de facto scarcity occur), the overall efficiency of water use is high (reuse of return flows), and most farmers incur costs to access water that is, therefore, neither free nor wasted. On the other hand, theoretically, savings could be expected if pricing was volumetric and high enough to affect farmers' behaviour, but this has not been verified.

Pricing as a reallocation tool

Improving irrigation efficiency is only one aspect of better using scarce water resources. Another potential benefit from water pricing could be to encourage a shift towards crops that are less water-intensive, and/or that display a better water productivity ($/m^3), or towards non-agricultural uses. Volumetric pricing would directly penalize crops with high consumption of water, but it could also be possible to establish water charge differentials based on crop type, that would

[4]The hopelessness of officials is apparent in public declarations: The Deputy Agriculture Minister reported in early 1998 that 'plantations in Nakhon Sawan, Tak and Kamphaeng Phet had increased to more than 670,000 rai from a target of 190,000' (*Bangkok Post*, 1999, 13 January), while the RID Director admitted that 'things are out of control', with 330,000 rai under cultivation, against a limit set at 90,000 rai (*The Nation*, 1999, 8 January). 'Our major concern is that we have no effective measures to control the use of water by rice growers. The only thing we can do is ask for their cooperation to cut down rice cultivation.'

encourage farmers to grow crops with lower water requirements. This runs into the same difficulties exposed in the preceding section regarding the elasticity of water use, the impact on farm income, and the constraints to metering volumes (crop-type-based fees escape this last constraint but face costs in monitoring effective land use). This rationale on crop selection often implicitly assumes that farmers do not diversify into field crops, vegetable or fruit crops *because* water is cheap or free, leading them to favour water-intensive crops (e.g. rice or sugarcane). This assumption also needs to be put in context.

In Thailand, the possibility of achieving water conservation by inducing a shift away from rice to field crops, which consume (ET) only 50–80% of the amount of water needed for rice, has long been underlined by policy makers and has formed the cornerstone of state projects aimed at fostering agricultural diversification (Siriluck and Kammeier, 2003). This was already a recommendation of the FAO as early as the 1960s, as well as the alternative that 'received the most attention' from Small (1972), in his study of the delta. Such a concern has been constantly expressed for at least four decades. Even nowadays, it is not rare to hear officials complaining off record, that 'farmers are stubborn', that 'they lack knowledge and only know how to grow rice' and that 'they oppose any change', despite being shown the benefits they might expect from it. Crop selection, however, is a more complex issue than merely choosing the crop with higher return to land or water.

First, the rationale for induced shifts in land use is generally – implicitly or explicitly – based on average farmers' income, overlooking the aspect of risk, which is crucial in shaping farmers' decision making. Even for irrigated agriculture, where yields are deemed to be more secured, risks in production are not negligible and include both agronomic hazards (diseases, pests, etc.) and a higher risk in marketing, further compounded by the higher requirements of cash input demanded by commercial crops. As a general rule, the potential return of capital investments is strongly correlated to the level of risk attached to the activity undertaken (Molle *et al.*, 2002). This is clearly exemplified by Szuster *et al.* (2003) in their comparative study of rice and shrimp farming in the delta. In other words, while cash crops may generate higher average returns, they are also subject to more uncertainty, either in terms of yields or farm-gate prices. Thus, only those farmers with enough capital reserve to weather the losses experienced in some years can afford to benefit from the average higher returns; others become indebted or go bankrupt. Shrimp farming in the delta, again, provides a good example of such a situation.

It could be argued, however, that the price of rice in Thailand is also unpredictable and that rice production suffers from uncertainty as much as other crops do. If the rice price does fluctuate, its crucial importance for the rural economy brings it under more scrutiny. Despite recurring complaints, echoed in newspapers, that rice farmers lose money when producing rice, the political ramifications of possible low prices and the outcry they instantaneously generate, largely shield them in reality from dropping under the break-even threshold.[5] Ad hoc public interventions are always implemented when such a risk arises (even though their impact generally falls short of expectations, and benefits tend to be captured by millers and other actors in the rice industry). This does not hold, however, for secondary or marginal crops (that invariably include the desirable 'cash crops'), and complaints of scattered producers have little chance of being heard in case of depressed prices. A typical example of such a cash crop is chilli, a rather capital- and labour-intensive crop, which can fetch B25/kg in one year (providing a high return) and B2 or B3/kg in the following year (with a net loss for farmers).[6]

[5]In addition, rice can also be readily stored and used for own consumption, or provided to relatives and friends.

[6]This situation differs significantly from that of western agriculture, where floor prices or 'intervention schemes' are generally established to compensate for economic losses when these occur. In addition, western farmers generally benefit from insurance (against exceptional yield losses) that comes with stronger cooperative and professional structures.

Second, several other constraints to diversification related to production factors are faced by farmers: labour may be lacking; for example, the harvest of mung bean, a typical supplementary crop with no additional water requirements, is often a problem because of labour shortage; capital is often required to transform the land (e.g. conversion to shrimp farms or orchards) or to invest in microirrigation; specific skills are necessary and not easily acquired by an ageing farming population; markets may be limited or the farmers not linked to them. Third, the delta agroecology, including heavy soils with little drainage and flood risk, is overall not favourable to growing field crops especially if neighbours are all growing rice. Fourth, the overextension of irrigation facilities, fostered by considerations of regional equity and by political patronage, makes it impossible to confine them to high-return agriculture only.

The last point is noteworthy. Farmers are expected to behave as rational profit-maximizers and they are not directly concerned with water productivity ($/m^3) but, rather, by the net income per unit of land ($/ha) as well as by the risk attached to a given crop or activity (Wichelns, 1999). There are several alternative crops to rice. A first group – vegetables, fruits and flowers – fares better in terms of income, water productivity and absolute water consumption. A second group – field crops, such as groundnut, mung bean and maize – uses less water, and may have better water productivity, but is generally less profitable and/or riskier with regard to selling prices. A third group – fruits in raised beds, aquaculture – includes crops with better income and water productivity but higher consumption of water. Considering these various options it is clear that water productivity may or may not be increased by a profit-maximizing cropping pattern.[7]

Siriluck and Kammeier's (2003) study of a large-scale public programme aimed at encouraging crop diversification in Thailand showed that such interventions are met with mixed success and are not flexible enough to adapt to different physical and socio-economic environments. In many instances, the attempt by extension workers to meet the 'targets' ascribed by the project has led to inadequate investments and choices, sometimes resulting in debts or bankruptcy. It is doubtful that 'pushing' for more diversification is eventually beneficial. Decisions should be made by farmers, based on their own appreciation of their environment and left to market mechanisms, in order to avoid exposing non-entrepreneurial farmers to bankruptcy. Evidence of the dynamics of diversification in the delta (Kasetsart University and IRD, 1996; Cheyroux, 2003; Molle and Srijantr, 2003) points to the fact that farmers display great responsiveness to market changes and opportunities (a point definitely confirmed by the recent spectacular development of inland shrimp farming: Szuster *et al.*, 2003). Good transportation and communication networks allow marketing channels to perform rather efficiently. Farmers will shift to other productions if uncertainty on water and sale prices is lowered. Time and again, Thai farmers have shown dramatic responsiveness to constraints on other production factors, such as land and labour for example (Molle and Srijantr, 1999), and have already sufficiently experienced the scarcity of water to adapt their cropping patterns, should conditions be favourable. Inducing crop shifts by raising differential fees to the level where they might be effective would substantially impact on farm income and critically raise economic risk, which is precisely the main factor that hinders diversification. While some potential may remain unrealized it is very unlikely that water would be a main constraint, or that pricing it would result in any significant shift.

The reallocation of water towards more beneficial uses can also occur across sectors. The issue is somewhat simpler, as few object to the fact that domestic and industrial uses are to receive priority over irrigation. Here

[7]An example of this contradiction can be found in Iran, or in Egypt, where rice appears as a productive and profitable crop, while being water-intensive, presenting a 'headache issue' (El-Kady *et al.*, 2002) to managers.

again, differential prices could theoretically help reallocate water, although water markets[8] are generally seen as being more efficient in theory. While the literature seems to underscore that there are significant potential economic gains to be expected from such transfers, it is apparent that in Thailand, this reallocation *does* occur and that non-agricultural activities are very little constrained, if at all, by lack of water. While the impact of the transfer of water out of agriculture is an important question (Howe *et al.*, 1990; Rosegrant and Ringler, 1998), leaving open the question of compensation, reallocation is taken care of by the state in several ways, as shown by the case of Bangkok Metropolitan Area (BMA): the growth of BMA generated a rise in demand from 0.46 million m^3/day in 1978 to approximately 7.5 million m^3/day in 2000, a 16-fold increase in 22 years (Molle *et al.*, 2001). This has been made possible not only by increasing the share of the Chao Phraya flow allocated to the city (up to 45–50 m^3/s) but also by using groundwater, with an average extraction around 3 Million m^3/day (TDRI, 1990). Future demand will be met by a recently completed canal which transfers water from the adjacent 'water-rich' Mae Klong basin (with a planned capacity of 45 m^3/s to be reached in 2017).

This shows, first, that the priority given to Bangkok has readily translated into an increased diversion of surface water (to the detriment of irrigation to the extent that it reduces the amount available in the dry season), and, second, that the impact of the shift has been mitigated by allowing industries to mine deep aquifers (at the cost of land subsidence and sustainability). Water from the Mae Klong basin will allow Bangkok to face future growth in demand, although possibly at a higher capital cost in economic terms than might have been possible if more water had been diverted out of agriculture in the delta area. This illustrates that Bangkok's needs are attended to in priority and that – despite its larger share in total water use – agriculture largely gets the leftover water in the system. Commentators, however, keep on asserting that the state has proved inefficient in centrally allocating water to the most beneficial use.[9] It is interesting to note the ubiquity of this argument even in settings where this problem has been handled relatively successfully.

Pricing and Cost Recovery

Justifications for cost recovery are diverse. One argument is that irrigators form a segment of society that has benefited from a specific capital investment by the state and, as such, are expected to channel back to the nation a part of the profit generated. If this logic of 'reimbursement' is often justified by notions of equity (redistribute part of the profits of those benefited), ideology (state involvement should be limited) or financial clarity (activities must be turned autonomous), shifts in public policy are generally motivated by more mundane reasons of 'financial drought'. We will examine here the rationale for cost recovery, as applied to the case of Thailand.

[8] A market is unrealistic in the present situation given the lack of control over volumes and of connectivity between users. The assertion that 'if the price of rice is low, [Thai] farmers would be happy to cede their right to industrialists' (Wongbandit, 1997) not only runs counter to the evidence that industrialists or cities are anyway served first, but also that physical constraints make such a reallocation impossible. How would the 'rights' of a group of farmers in, say, Kamphaeng Phet (middle basin) be transferred to a given golf course or factory in the suburbs of Bangkok?

[9] A typical example is provided by Christensen and Boon-Long (1994): '[A] concern which could raise problems in the area of basin management involves the authority of the basin authorities to impose allocation priorities. . . . The burden of proof for such an initiative is to show that command and control could result in better allocations and less market failure.' Israngkura (2000), for his part, considers that 'the returns on the irrigation dam investment have been low due to the lack of effective water demand management that could prevent less productive water utilisation'. This suggests that the assumed low return of irrigation has deprived other potentially more productive use, whereas irrigation is, in fact, largely allocated the leftover in the system.

Equity, redistribution and the overall arithmetic of rice production

A first line of debate is about whether, indeed, irrigated agriculture can be said to have benefited from a preferential treatment within the national economy and, thus, whether – out of a concern for equity – water pricing as an additional government tax is justifiable as means to: (i) return part of its value-added to government coffers; or (ii) allow, in particular, further investments in the non-irrigated agriculture sector (FAO, 1986).

It is necessary, therefore, to examine whether irrigated agriculture, and in particular rice cultivation, is – overall – subsidized or taxed. Thailand has long chosen to tax its agricultural exports (Schiff and Valdés, 1992) and to recover her investments in irrigation through indirect mechanisms (Small *et al.*, 1989). The revenues siphoned by the state off rice cultivation through the mechanism of the rice premium, between 1952 and 1986, have been estimated at 25% of all rural income (Ingram, 1971; Phongpaichit and Baker, 1997) and it is clear that rice farmers have indirectly paid back more than any realistic water fee. It was estimated that in 1980 these indirect revenues amounted to three times the O&M costs (Small *et al.*, 1989) while capital cost recovery reached uncommon levels. Indirect taxation may be inequitable but is quite efficient since it avoids the costs of collection and the possible corruption that may come with it (Hirschman, 1967). Because declining food prices in the last two decades (driven, in large measure, by the increase in reliable production from irrigation investments) have depleted the surplus that could be extracted from agriculture, these indirect revenues have now dwindled down, being captured as consumer surplus.

This questions the rationale used by consultants to support cost recovery: 'Thai taxpayers are paying B35 billion a year to run RID. If this is worthwhile to the farmers then why should the taxpayers have to pay for RID?' (H&P and A&E, 2000). This question stems from a narrow definition of what 'taxpayers' pay for and ignores the more global arithmetic of sectoral taxes, subsidies and cross-subsidies, not to mention the distribution of benefits to consumers and multiplier effects in the economy. Indeed, rice farmers have probably contributed more to the rest of society than they have received from it, both through taxation and impact on rice market prices.

One might argue, however, that this holds for the past but that the situation has changed. Leaving aside the argument that the water subsidy could be seen as a (small) compensation for the past pattern of indirect, yet heavy taxation, a water fee could be now construed as a charge reflecting the costs of providing irrigation water. This argument differs, depending on whether one considers that: (i) the disappearing of the premium reflects an increasing rice supply in the international market and a decline in real price (squeezing farmers' income and rendering the extraction of surplus unsustainable); or (ii) it stemmed from the growing political clout of a rent-seeking rice sector. Since the evidence unambiguously points to the first interpretation (Isvilanonda, 2001), this can be taken as an indication that rice incomes are now squeezed and that further taxation would have substantial socio-economic and political implications.

Another major argument regarding equity is that of discrimination against rain-fed agriculture, resulting from both the subsidies in capital costs and the supply of free water, since the irrigated sector can produce more per unit of land than rain-fed agriculture and better absorb the impact of declining rice prices driven by overproduction (and, initially, by taxation). Such concern for equity is often mentioned by officials and ADB consultants ('60% of the budget of the Ministry of Agriculture went to 20% of farmers' provided with irrigation). This militates for closing the gap between the two subsectors, for example, by having irrigators bearing the cost of water delivery. This argument is valid when applied to the initial phase of irrigation development, when rain-fed farmers disproportionately bore the costs of the rice premium and low prices, although this was smoothened by the fact that rain-fed production was mostly for home consumption and little for the market. In addition, initial differences have now been evened out by the evolution of farming systems: in the mid-term, average farm size and the degree of farm fragmentation at inheritance appear to be in line with the average income derived from a unit of land. Molle *et al.* (2002) have studied three sub-areas of the Chao Phraya delta where cropping intensities and return to land per year markedly differ. The study showed that differences in annual land productivity were largely compensated over time (albeit not fully) by growing differences in farm size, family size (linked to the rate of migration) and pluri-activity which partly rebalance final farm incomes.

Rice as a global commodity

Another relevant issue is the international dimension of subsidies, as many of these commodities, notably rice, are traded in international markets. The insistence on having farmers pay the 'real' cost of water can first be questioned when European and American agriculture is admittedly heavily subsidized (Sarker *et al.*, 1993; Baffes and Meerman, 1997; CRS, 2002). This applies especially for crops that compete in international markets – here the price is substantially set by the lowest (net)-cost producers – and it is not clear why developing countries should adopt policies which are not part of the agenda of their western or East Asian competitors. The US Congress, for example, provided $24 billion between October 1998 and 2001 to shield growers against low prices and crop disasters (The Nation, 2001). In May 2002, another 10-year $190 billion farm bill was signed by President Bush. This concerns, in particular, rice production whose revenue includes a share of 50% of subsidies (USDA, 2001, web site). Complying with orthodoxy (full operational cost recovery and 'real' factor prices), on the one hand, and disregarding it entirely, on the other, through intervention when benefits get squeezed by declining prices, illustrate that a real-cost regulated market is not yet in place for reasons that are far broader than water pricing.

An additional difficulty for Thai rice farmers comes from their wide linkage with international markets. Whereas in many markets a change in input prices is readily passed on to the consumers, albeit partly depending on the structure of the market, this does not easily occur for commodities where producers mostly operate as 'price takers', for example, because of links to international markets. In the case of rice, the Thai farm-price elasticity relative to the world-market price is 0.8 (Sombat Saehae, by e-mail, January 2000, personal communication). It follows that farm-gate prices are predominantly driven by the world market and that internal balancing mechanisms to reflect changes in factor prices are critically constrained, to the detriment of producers.

O&M expenditures, financial drought and payment for service

The need for 'cost-sharing', however, may become more pressing when the government is faced with financial squeeze and seeks to reduce expenditure, while the deterioration of irrigation facilities impinges on productivity and farm income, and gives way to costly recurrent rehabilitation programmes. Such deterioration appears relatively limited in the present case (RID's maintenance, especially in the Central Region, can be considered quite good if compared with many other countries), and there is no evidence that financial squeezes, even after the 1997 economic crisis, have drastically altered RID budgets or its capacity to carry out maintenance work. In Thailand, O&M costs are said to correspond to a 'huge drain on the national budget' (H&P and A&E, 2001) but these costs must be put in context[10]: the potential gains from the cost-sharing policies proposed represent 0.37% of the value of Thai agricultural exports, 0.27% of Thai government expenditures or 15% of the

[10]The proposal by ADB's consultants was to set up a tentative fee of B120/rai in pilot projects. This value was intended as a compromise derived from the total estimated O&M costs: B522/rai, out of which B210 were true direct costs (H&P and A&E, 2000).

RID budget itself. Savings of 0.27%, not considering the transaction costs corresponding to the collection of fees, may be not negligible but certainly not considerable when compared with the political risk attached to it. Thus, it seems that the financial squeeze that was one of the major drivers of the Philippine NIA and of the Mexican reforms is not (yet) a crucial incentive to change in the Thai case.

An important distinction must be made between cost recovery that goes to the government coffers, and irrigation financing, that is the provision of funds actually used for irrigation costs (Small, 1996). Surprisingly, the Royal Irrigation Act of 1942 recognized this fact early. It made it legally possible to charge users for water (despite fixing unrealistically low limits), but stipulated that collected money could not be considered as state revenue and should constitute a special fund to be put back into the development of irrigation. If this is the case, and if users are granted partial or total control of the allocation of these funds, then incentives to pay and limit degradation are created and a sense of 'property' may emerge. More generally, it is the potential role of pricing at the interface between line agencies and users, which deserves emphasis (see next section).

Raising fees that only contribute to the government income is a measure that is not conducive to internal improvement and is, therefore, a decision pertaining to the design of the tax system as a whole: making users bear a part of O&M costs is helpful in internalizing costs from the point of view of the government, but shifting this financial burden has to be reasoned, based on wider public objectives of poverty alleviation and wealth redistribution, sectoral policies, possible treasury difficulties and political risks, which are all dependent upon the context of each particular political economy. Schiff and Valdés (1992) showed how governments are caught up in a web of contradictory goals, including protecting farmers, protecting consumers from high food prices, raising revenues through taxation and ensuring the competitiveness of economic sectors in the world market. This makes decision making more complex than just embracing the principle of cost recovery. The question raised here is how governments can change their policy, for example, from providing public goods for free to charging for it, without providing compensation.

To conclude this section it is interesting to draw a parallel between charging for irrigation water and charging for groundwater use. Charging for groundwater use is backed by strong economic justifications because of the critical costs of overdraft in terms of land subsidence and increased flood risk and damage. Yet the constraints faced in establishing such charges illustrate what is at stake. Groundwater use mostly concerns industries in BMA and has remained admittedly underpriced, largely because of the political clout of both the Federation of Thai Industries.[11] All in all, charging for irrigation water use may be a more difficult business – both socially and technically – than charging for groundwater, which lends itself much more easily to control and volumetric charging.

Recent Attempts to Reform the Water Sector and Future Prospects

Further to the 1997 financial crisis, Thailand obtained a $600 million loan from both the ADB and the Japanese Bank for International Cooperation under the name of Agriculture Sector Program Loan (ASPL), conditional upon acceptance of some principles and a reform of the water sector (RWS). A policy matrix was defined, showing commitment and successive milestones to be achieved. The RWS was designed by consultants to the ADB and issued in March 2001. It included several components (H&P and A&E, 2001):

- Strengthening of the Office of the National Water Resources Committee (ONWRC) and transforming it into an apex body;

[11]The federation opposed a gradual rise of the groundwater price (from B3.5 to 8.5/m³, in an attempt to catch up with tap water at B12.5/m³), stating that a price of B5 would 'lead to hardship'. Recently, the Thaksin administration seems to have adopted a more energetic stance and given deadlines for the phasing out of wells in areas where pipe water is available.

- Decentralization of water management to river basins;
- Watershed protection strategy;
- Setting of performance indicators and service standards;
- Participatory irrigation management (PIM) and definition of farmers as clients rather than beneficiaries;
- Cost-sharing of O&M;
- Reorganization, decentralization and privatization of RID.

In parallel, the National Water Resource Committee was drafting a Water Law which was supposed to encapsulate many of the crucial aspects of this ambitious reform, notably the establishment of River Basin Committees (RBCs), and the separation of the water policy, management and O&M functions. It is beyond the scope of this chapter to discuss the merits of the proposed reform but the aspects of cost-sharing, service agreements and participatory management are relevant to our current discussion.

The RWS aimed at establishing a contractual relationship between RID as *provider* and farmers as *clients*. It was expected that such agreements duly defined through established standards and monitored through performance indicators would significantly increase the quality of delivery, thus justifying the principle of cost-sharing put forth (as opposed to cost recovery). This would set in motion a virtuous circle whereby farmers would get financial autonomy and better service, while participating fully in the definition of operational targets and maintenance priorities. This virtuous circle is well identified in the literature (Small *et al.*, 1989; Small and Carruthers, 1991; see Molle and Berkoff, Chapter 1, this volume) but it has several prerequisites that were overlooked in the RWS.

The first crucial weak point of the reform was that there was no provision to ensure that RID will deliver water, following standards of service agreed upon. By failing to link RID's financial income to such service, no drastic pressure would be put on RID to reform its management and it is highly doubtful that raising their awareness of the necessity of change by seminars or capacity building would be sufficient to ensure this. When fees contribute significantly to the salary of the officials of the agencies, or are used to pay field staff who are selected by the users themselves, there is a real change in the governance pattern of irrigation. This, of course, was the most contentious part of a reform and the one that was likely to be compromised.

Service agreements were supposed to be established between users and RID but little was said about whether the existing human and physical capacity needed to achieve this, exists or not. After the early overemphasis on structural aspects, it has now become all too common to disregard the physical dimensions of management and to overlook their impact on reforms (Briscoe, 1997; Facon, 2002). Water management in the Chao Phraya basin is constrained by various aspects, including the lack of control over abstraction along the waterways, the occurrence of side flows, the crude technical design of most hydraulic regulation structures and the development of conjunctive use by farmers (Molle *et al.*, 2001; Molle, 2004). This makes the definition of service agreements at lower levels extremely problematic. The RWS made no provision to ensure that hydraulic regulation was up to the task envisaged. It just assumed that 'farmers will receive improved irrigation service delivery. Farmers need to feel confident that service is being improved' (H&P and A&E, 2001).

Initial service agreements were to be developed at the project level between RID and Water User Groups (WUG): '[A]s soon as WUG get ready . . . as federation of water users moves up the system, to IWUGs and WUAs, service agreements will move with them.' This was the second weak point of the reform. As is the case in many failed reforms of PIM, farmer organizations are first built at the tertiary level. This is easily accepted by irrigation agencies because they usually have no interest in what is occurring beyond the tertiary turnout and blame for deficiencies can then be placed if required on the farmers themselves. Since certainty in supply at the tertiary level generally depends on allocation and distribution at higher levels in the system and cannot be fully ensured, farmers soon discover that there is nothing to be managed and that they are wasting their time. Present reforms still consider water management at the tertiary level and maintenance as crucial issues but these may actually have lost importance in the eyes of farmers. As a result of the ongoing decentralization process, local administrations have seen their budget increasing and are now using the resources under their control to fund maintenance (notably mechanical ditch dredging). Likewise, the organizational needs of water management have been radically changed further to the introduction of direct seeding in lieu of transplanting, the development of secondary water sources and the spread of pumps. This has weakened the exigency of collective action and fostered individual strategies.

In contrast, the issue that has gained prominence in a context of water scarcity is the allocation of water in the dry season (Molle, 2004). The process towards involving users in management should be initiated by allowing a transparent allocation process in which users would have representatives at each level (main canal level, scheme level, plus the delta and basin levels for farmers in the Chao Phraya delta). The definition of (seasonal) entitlements in which users have a say (as a first step to defining water rights) is the preliminary step to the definition of service agreements. Such agreements must be accompanied by a technical capacity to operationalize them, to monitor distribution and to assess whether the actual and the agreed supply match. This, again, has technical, managerial, legal and political implications that need combined support from the government, the political class and the society, which does not seem to be forthcoming. A part of RID officers' foot-dragging in considering the issue might be linked to the fact that establishing service agreements and a water charge may eventually backfire, in that farmers would be given 'the legal standing to bargain forcefully with the water conveyance bureaucracy for timely and efficient service' (Rosegrant and Binswanger, 1994).

The reform process initiated under the ASPL has been phased out during 2002 and 2003. Pilot projects have been implemented partly, and without supervision, leading to no real change. Cost-sharing policies and service agreements have disappeared from the front scene. The draft Water Law has been shelved. The restructuring of RID has been limited to measures such as the non-replacement of retiring staff. Only the setting of RBCs has proceeded, under the guidance of the ONWRC. At present, however, RBCs still lack the formal recognition that would give them more importance than a mere consultative forum. The failure of the reform can be partly attributed to some of its internal weaknesses (over-optimism, structural constraints to the definition of service agreements, misplaced emphasis on building from the tertiary level, etc.) but was chiefly undermined by the lack of support from the Thai side, from both bureaucratic and political quarters. Its final dismissal came with the decision of the Thaksin administration to discontinue loans from the ADB. This failure exemplifies disregard of what Briscoe (1997) considers the first requirement for reform: that there be a demand for it. However sound and well intentioned they may be, reforms decided and imposed by external institutions have little chance of succeeding.

In addition to the lack of strong political commitment and support, and of structural rehabilitation, the reform failed to ensure the crucial point of financial autonomy. Financial autonomy makes the water charge a 'glue factor' in a wider process of transfer of responsibility to users, who can decide on the hiring of staff and the priorities in maintenance which are ensured by their own funds. This factor, crucial in the Mexican reform, was absent from the ASPL and raises the question of whether a partial reform can achieve partial benefits or whether it is doomed to failure because of the absence of crucial linkages in the virtuous circle to be created.

Conclusions

Pricing mechanisms are often held as a potential tool to help 'rationalize' the use of water in ways that increase the economic efficiency of both water use and allocation. Application of such measures has been met with some success in the domestic and industrial water sectors but has so far failed to produce convincing examples in the large-scale public-irrigation sector of developing countries. In the particular case of Thailand, both the rationale and the applicability of such measures were found to be problematic.

The idea that water waste would be a consequence of the non-pricing of water was little supported by evidence. The closure of river basins, most notably the Chao Phraya basin, is accompanied by reductions in losses, both at the farm and the basin level, with only 12% of dam releases in the dry season lost to non-beneficial use: a reality which contrasts sharply with the image of outright waste that is routinely conjured up to justify pricing as a way to induce water savings. The technical impossibility of establishing volumetric water deliveries, as well as the wholesaling of water in the present context, removed the possibility of influencing users' behaviour through pricing. Even if this is possible, there are indications that the elasticity of water use is very low at the range of prices proposed to meet appropriate cost recovery objectives, in addition to the political difficulties in implementing them.

The possibility of inducing land-use shifts towards crops with higher water productivity runs into similar difficulties. It was shown that farmers' decision making gives much emphasis to risk, and that water savings or water productivity objectives do not necessarily coincide with income maximization. To assume that there are substantial gains to be expected from shifts in cropping patterns if water is priced is to misunderstand the dynamics of, and constraints to, diversification. If much higher profits could readily be made through diversification, farmers would not wait for this. To penalize rice because of its higher water needs would only raise the vulnerability of the main crop, without making alternatives more secure or removing the other constraints to diversification, particularly the need of stable markets. Likewise, few economic gains can be expected from intersectoral reallocation of water, as non-agriculture sectors are already given de facto priority.

The principle of cost recovery is generally propped up by an image of irrigators who have unduly benefited from government largesse and are expected to pay back the 'taxpayers'. This was confronted with the net transfer of wealth from agriculture to other sectors, symbolized in Thailand by 30 years of rice premium, and with the multifaceted benefits of irrigation accruing to the society. It was also recognized that political considerations and national challenges, such as food security, rather than mere aspects of return to capital, dictated earlier priorities in state investments and that shifts in policy are not easily justified and implemented.

A water charge would be akin to a flat tax that would decrease farm income, without effectively sending a signal of water scarcity, and decrease international competitiveness (especially with regard to western countries that continue their policy of subsidy), while it would not be easily passed on to the consumer because of the strong linkages between domestic and world rice markets. While reductions in price subsidies in developed countries are compensated for by adequate income policies, the latter are generally omitted in developing countries (partly due to the difficulty in implementing such income-support schemes). Shifting, even partly, the O&M costs to the users is helpful in internalizing costs from the point of view of the government and signalling to all concerned the real cost of system O&M. It may help ensuring financial sustainability if public budgets happen to be lacking, but has socio-economic and political implications that need to be addressed.

Beyond 'the obsessive traditional concern on the part of resource economics with correct pricing levels for irrigation water' (Svendsen and Rosegrant, 1994), water pricing is made more attractive when it is construed as a binding element of a wider mechanism that redefines relations between users and the agency (Small and Carruthers, 1991; Bromley, 2000). It gains sense if a full reform is implemented that includes a degree of turnover and financial autonomy whereby water delivery service is paid for by users and linked to the quality of service. Service agreements should include definition of the allocation of resources and of the timing of the distribution of allotments. In both processes, the users should have a say, given their importance in a context of scarcity. Modifying the status of public agencies and civil servants in order to link their salary to performance and to the payment of users requires a much more ambitious reform in the direction of which the government has so far taken no unequivocal steps.

The failure of the ASPL reform illustrates several lessons that failed to be learnt, in particular, the importance of infrastructure in the design of service agreements or bulk allocation, as well as the necessity to muster internal and political support for the reform. Emphasis thus, should be placed on paving the way for a thorough reform, ensuring in particular, the technical and managerial capacity to define and operationalize services, as well as the legal framework and the political/public support for changes in line agencies. Failing to alter the pattern of governance jeopardizes reforms which remain generally restricted to isolated components, backed by arguments that are turned invalid. It is not clear, therefore, whether 'half-measures' provide 'half-benefits', and must be seen as 'second-best' options, as economic parlance suggests, or if they are likely, because of the absence of linkages and invalid supporting assumptions, to fail and lead to an overall negative result, rather than to the theoretical gains envisioned. All in all, it appears unwise to propel water pricing to the fore of the reform, as a symbol of restored economic orthodoxy, when it is expected to play a more crucial and later role in a wider and longer reform process.

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7 Who Will Pay for Water? The Vietnamese State's Dilemma of Decentralization of Water Management in the Red River Delta

J.-P. Fontenelle, F. Molle and H. Turral

Introduction

Many state-run large-scale irrigation schemes worldwide have long been financially supported by public funds. Because of stretched public finances and a general trend to hand over the management of irrigation schemes to farmers, an emphasis is often placed on both cost recovery and the financial autonomy of these schemes. Water fees in most countries generally cover only a part of operation and maintenance (O&M) costs and amount to a small percentage of the agricultural gross product, typically less than 10%. In some other countries, water supply is free and is considered to be a state obligation. However, in situations where irrigation and drainage operations demand the use of pumping devices, operational costs are generally significantly higher, as they include the costs of energy and the maintenance of equipment, and consequently water fees also tend to be higher. This is the case in the Red River delta, where thousands of pumps of all capacities are used in water management.

The Red River delta is also well known for having one of the highest rural population densities of the world. Consequently, agricultural production is extremely intensive, cropping intensity is high and the proper management of water is paramount in achieving social welfare and food security. The relationship between the state and the farming population has seen dramatic changes, from colonial times to the recent liberalization, throughout the collectivist period. The question of financing irrigation must therefore be addressed as a particular aspect of a changing political economy, where the taxation system and the roles and responsibilities of the different actors are being redefined. With all these changes, the pumping costs of irrigation and drainage have yet to be covered. This warrants an investigation into how water pricing is conducted in the Red River delta and who eventually pays for what.

The first section of this chapter describes the political changes which induced the technical and institutional evolution of this delta's water control systems, as the organization of the operation and even the technological nature of these systems were influenced by national political choices. The second section describes the management framework and the financial organization of the delta's water control systems. In-depth studies conducted at local level provide a better understanding of the present situation.[1] Water management in the Red River delta appears to be strongly organized by the state into successive nested levels, from the central level of the Ministry of Agriculture to the local level of the cooperatives. This structure has been challenged by the emergence of local pumping stations and water management practices, which have superimposed themselves upon this bureaucratic structure. It is shown that the mismatch between administrative and hydraulic units adds to the complexity of the definition of both the financing and the management of hydraulic operations. The third and last section of this chapter examines the financing of the different operators, the amount and use of the water fees paid by farmers, and questions the process of water management decentralization and 'privatization'[2] in the delta. While there is scope for improving downward accountability to farmers, the present system of bulk pricing and nested levels of subsidiarity allows a relatively high rate of cost recovery and a relative financial self-sufficiency.

The Evolution of the Red River Delta Water Control Systems

With a population of more than 75 million and a total area of 331,700 km², of which only one-third is covered by plains, Vietnam shows much concern for its food security (Cuc *et al.*, 1993; Fforde and Sénèque, 1995). Fertile and crowded plains, notably the Mekong and Red River deltas, play a key role as the country's rice bowls. The Red River delta is the smaller and more densely populated of the two deltas (Fig. 7.1). It has a gross area of 1.5 million ha (or 4.5% of the total area of Vietnam) and a total population of 20 million (27% of the total population of Vietnam) (Le Ba Thao, 1997). This represents one of the world's highest rural population densities, with more than 1300 inhabitants/km² in some areas. This explains why agricultural intensification, anchored in a strong security against climatic vagaries provided by irrigation, drainage and flood-protection infrastructures, is such a vital issue for the Government of Vietnam.

Water control before collectivization

High population density is not a new feature of the Red River delta. Population density was already above 400/km² at the beginning of the 20th century (Dumont, 1935; Gourou, 1936). This delta is an area of ancient human settlement where reclamation by paddy growers has been proved to date back to more than 2000 years (Sakurai, 1989). Early and dense settlements are quite conspicuous, judging from the unfavourable natural conditions faced by the population living in this delta: dangerous river floods and occasional typhoons, as well as droughts, are common during summer monsoons. During dry winter and spring seasons, the main concern is accessing water for irrigated agriculture. To minimize the impact of these constraints, large-scale water control works, such as dykes and canals, were initiated by the imperial state more than eight centuries ago and developed during the 19th century before the arrival of the French (Chassigneux, 1912). Dykes protected the Vietnamese population from floods during the monsoon[3]; during the dry season, canals could receive water

[1] This description is based on the results of the 'DELTAS' INCO-DC research project, funded by the European Union (DG XII). In Vietnam, the project was implemented by GRET (Paris) and the Vietnam Agricultural Sciences Institute (Hanoi) between 1998 and 2000. Additional information is sourced from ACIAR (Australia)-funded project 9404 'Integrated management of pumped irrigation systems in the Red River Delta – 1995–1998', carried out with the Vietnam Institute of Water Resources Research.

[2] The term 'privatization' may be ambiguous and is understood here as the emancipation from the state of groups of users who are able to manage their pumping stations and irrigation schemes independently. However, these undertakings are communal, theoretically non-profit-oriented, and have often been made possible thanks to public funds.

[3] The monsoon in northern Vietnam is characterized by high precipitation and frequent typhoons (Taillard, 1995; Le Ba Thao, 1997).

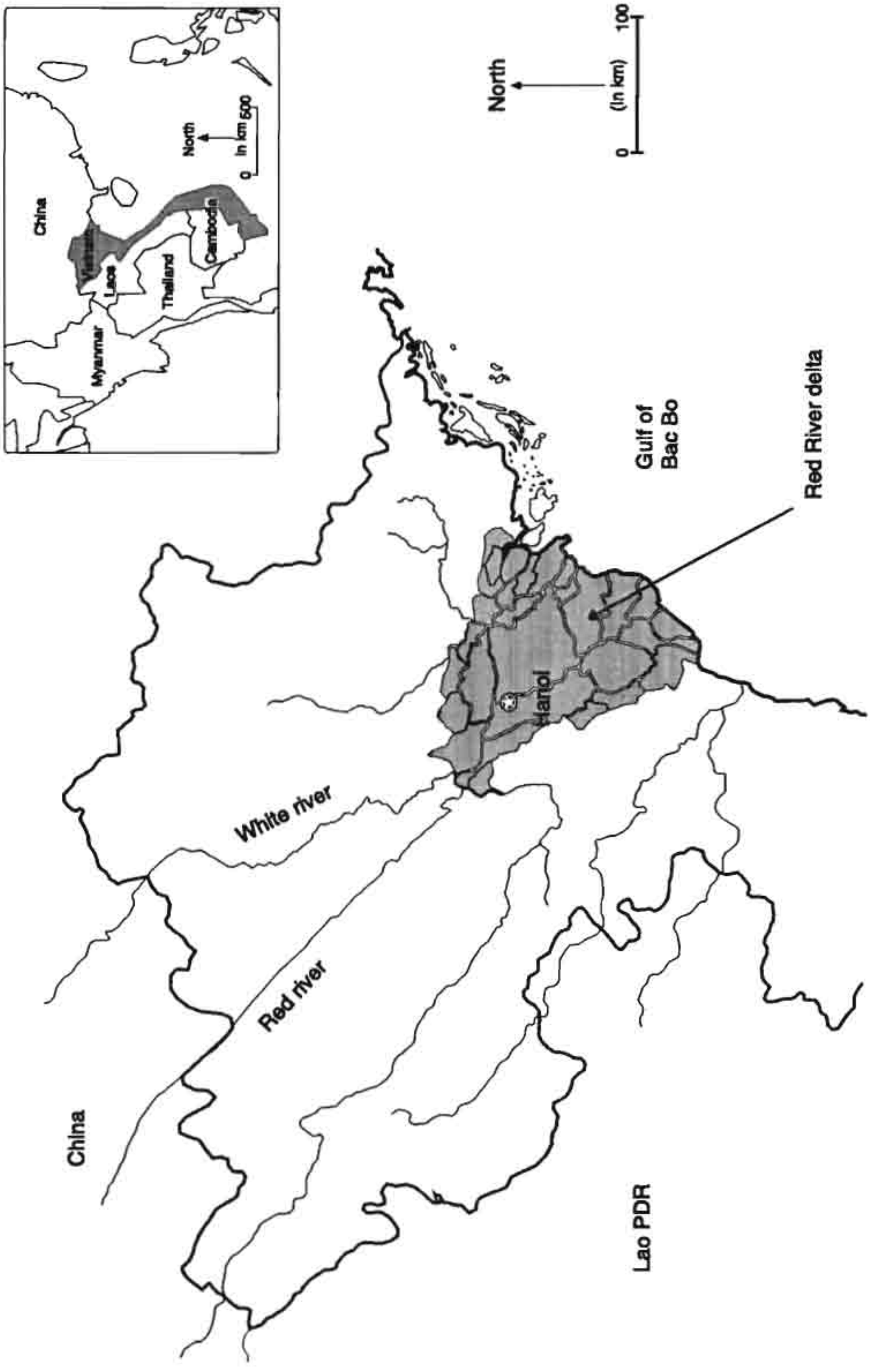

Fig. 7.1. The Red River delta in Vietnam.

from the river (through sluices in the dykes) and channel it to the lowest paddy fields, gravity allowing. To secure and intensify paddy agriculture, individual irrigation equipments such as water-lifting baskets and tripod scoops were introduced through Chinese influence, which lasted in Vietnam for 1000 years.

The imperial state took responsibility for the construction of dykes, water gates and main canals along river banks by mobilizing local (forced) labour. The responsibility of irrigation was left to the villages (*lang xa*) (Fontenelle, 1998). During the French colonization, state investment in hydraulic works increased dramatically, with the improvement and completion of the Red River delta system of dykes, gates and the network of main canals. Although the combined action of the central state and farming communities had already gone a long way in developing intensive agriculture in this delta, the farmers' situation remained uncertain due to the occurrence of droughts and floods, as well as the imposition of taxes and the burden of forced labour (Hémery and Brocheux, 1995). Poor drainage within the polders[4] resulted in continuously saturated conditions and a predisposition to rapid flooding, as the water levels in the river were (and still are) higher than in the surrounding paddy fields during the rainy season. As regards irrigation, low levels in the river made manual water lifting necessary and hindered rice development during the dry season.

The centralized modernization of water control

The modernization of water control in the Red River delta began in the 1960s under the policy of agricultural collectivization and with the establishment of cooperatives. The modernization of water control was considered a strategic mission, as a necessity towards the collectivization of agriculture. The combined effects of collective mobilization for hydraulic works and the improvement of agricultural conditions were supposed to encourage popular participation in the new cooperative system (Yvon-Tran, 1994).

The state placed great emphasis on mechanized drainage and irrigation. In 1962, 9.8 million man-days of labour were recorded against 2.3 million in 1959. In the Hung Yen province alone, 4000 km of canals were dug at the end of 1963. More than 80% of the direct investments in agriculture by the state were dedicated to the improvement of water control. Large drainage and irrigation schemes were created with a comprehensive network of canals, from the primary to the tertiary level, channels connecting polders to rivers, and large-scale irrigation and drainage pumping stations. Between 1961 and 1965, more than 2500 pumping stations were reportedly[5] set up in the Red River delta (Vo Nhân Tri, 1967 quoted in Yvon-Tran, 1994). By 1966, 73% of the cultivated area of the Red River delta was equipped with electrically powered irrigation and drainage pumping stations. Thus water could be extracted and supplied without human labour (Lê Thanh Khoi, 1978). These works, combined with the introduction of improved paddy varieties and chemical fertilizer, led to the further intensification of agriculture and to the double cropping of rice throughout the delta. Beyond the mere modernization of infrastructure, the way in which the Government of Vietnam intended to manage water supply also changed. From a situation where local management at the village level prevailed, water management was transferred to the state, provincial and district water services. Water distribution was organized according to strict irrigation turns among all cooperatives belonging to a single irrigation scheme, and farmers were effectively excluded from the water distribution process (Fontenelle, 1999).

[4]The Red River delta is divided into 30 independent hydraulic units, which are fully dyked and surrounded by arms of the river. These are called polders or *casiers*, in this chapter.

[5]These official statistics are subject to caution. However, there is no doubt that the 1960s witnessed a massive development of large-scale pumping stations.

However, the improvement of food security in the Red River delta did not last long. Between 1960 and 1975, the population resisted and resented the move towards collectivist economy and cooperatives. This, combined with the dysfunctional centralized management, appeared to have compounded an emerging economic crisis (Kerkvliet, 1999). The situation worsened at the end of the 1970s, when the government tried to sustain the collectivist economy through further heavy investments in water control equipment and stronger centralization of production management. Drainage capacities were upgraded through investment in new pumping stations with higher discharge capacity. Most village cooperatives were aggregated into commune cooperatives. Districts became responsible for all production aspects, including the establishment of the crop calendar, choice of rice variety and the management of hydraulic structures. This policy failed dramatically and the very poor living conditions of farmers sometimes degenerated into starvation (Nguyên Duc Truyên, 1993). The food crisis faced in this delta at the end of the 1970s was not the result of a lack of production capacity or funds, since water control infrastructures were well developed by then. This crisis appeared to be due to excessive state intervention, which undermined the capacity of farmers to innovate in, and take control of, production. The crisis was political rather than technical (Tessier and Fontenelle, 2000).

Liberalization reforms and decentralization of water control

This situation lasted until the beginning of the 1980s, when Vietnamese authorities recognized the failure of the 'great socialist agriculture' and proposed, through the *Khoan 100* (Directive 100), a new contract for production with farming households. This contract, in which paddy land was leased to households for a fixed contribution and the surplus of production left to farmers, arose in a context of an economic crisis compounded by farmers' rejection of collectivism (Beresford, 1988; Kerkvliet, 1995). The directive resulted in a boom in agricultural production and encouraged farmers to claim fuller responsibility for agricultural production, including the supply of water. The aspirations of farmers could not be satisfied through the strict rotation of irrigation turns which prevailed in centrally managed schemes. First, individual land management created the need for a specific access to water for each small field leased to farmers, in contrast to the former organization of water supply on large collective plots[6] (Mai Van Hai, 1999). Second, a strict organization with the establishment of a collectively fixed crop calendar did not allow for the diversification of crops and paddy varieties (Fontenelle and Tessier, 1997). The negative impact of this constraint was reinforced in the case of droughts or power cuts. In order to improve local irrigation conditions, farmers and cooperatives had to free themselves from their dependency on centralized irrigation systems. Farmers deepened existing tertiary canals to store water for a few days after pumping and to gain some flexibility in irrigation at the farm level (Dang The Phong and Fontenelle, 1995).[7] Cooperatives set up local pumping stations to get direct and autonomous access to water supply (Fontenelle and Tessier, 1997). These pumps were financed by revenues from cooperatives and subsidies from the state. Local pumping stations abstracted water from *arroyos*[8] and from the canal networks built by the state in the 1960s. Local irrigation

[6]Reality, however, is diverse. In other areas, like Dan Hoai and La Khe polders, the water management groups still do the bulk of in-field water management. Because of the disaggregation of holdings due to land reform, farmers find it too difficult to manage water individually.

[7]This added to significant secondary storage and in-drain storage within command areas, which tapped direct supply or return flow from the 'centralized' irrigation systems, which had long been developed.

[8]The term 'arroyo' is used to define the network of natural drainage channels and the lands lying in between that, in most cases, are now bounded by dykes.

schemes thus emerged as fragments of the old centralized irrigation schemes.[9]

The construction of local pumping stations increased during the 1980s taking advantage of further political reforms initiated by the government. In 1984, through Directive 112/HDBT, the central government decreased its involvement in water management, not only partly devolving management of water control services but also strengthening mechanisms aimed at balancing revenues and costs under strong provincial control. A new actor, the Irrigation and Drainage Management Company (IDMC), was created in each polder. The IDMCs are public companies owned by the state, which were supposed to balance their accounts through the collection of a water fee paid by the cooperatives. They are essentially bulk water suppliers. Furthermore, the *Doi Moi* reform in 1986, which resulted in the abolition of subsidies and in the liberalization of production activities, the *Khoan 10* (Directive 10) in 1988 and the Land Law in 1993, which governs the redistribution of land to farming households, created new conditions for water management and agriculture. Finally, in 1996, the state issued a law on cooperatives aimed at improving their management in a way reminiscent of the 1984 reform of the IDMCs. Cooperatives were no longer considered responsible for production and were supposed to provide service to farmers, for which they could charge a fee. They were still responsible for the collection of water fees paid by the farmers.

Agriculture became more diversified and intensive, as farmers gained the freedom to manage their production individually. Farmers diversified the number of paddy varieties they used, adopted direct seeding techniques, and increased commercial crop production, especially during the winter season (Lê Duc Thinh and Fontenelle, 1998; Bach Trung Hung *et al.*, 1999). These changes had an impact on water demand, both in terms of overall requirements and frequency of supply (Mai Van Hai, 1999). To meet these requirements the cooperatives increased the number of local pumping stations in order to get more autonomy and flexibility in water supply. These stations now serve approximately half the irrigated area of the Red River delta. High population densities do not seem to have jeopardized food security in the Red River delta as it did in the past, as agriculture now provides more than 300 kg of paddy per head per year (Dao Thê Tuan, 1998). Agriculture is very intensive and the paddy production of this delta accounts for up to 22% of all Vietnamese rice production. The people of this delta seem to successfully combine a high population density with intensive agriculture and strong water control measures.

[9]Built along arroyos from which they abstract water, local pumping stations also benefit from the presence of former centralized irrigation canals built on the side of arroyo banks. Therefore, centralized irrigation canals are cut into several reaches, which become primary irrigation canals of the new local irrigation systems.

Institutional and Financial Framework of Water Management

This section focuses on the example of the Bac Hung Hai (BHH) polder. It is the largest polder and the first in which hydraulic modernization was implemented at the end of the 1950s. With an extension of 210,000 ha, 185,000 ha of which are protected by the dyke system, 126,000 ha cultivated and 100,000 ha irrigated, the BHH polder makes up 13% of the total area of the delta. It includes 15 districts from four provinces: Hanoi Metropolitan area (1), Bac Ninh province (2), Hung Yen province (6) and Hai Duong province (6) (Fig. 7.2). In 1996, the number of pumping stations in BHH totalled 1022, including 698 local stations.

National and provincial administrative levels

In 1995, the former Ministry of Water Resources, the Ministry of Agriculture and Food Industries, and the Ministry of Forestry were combined into a new Ministry of Agriculture and Rural Development (MARD). The Department of Water Resources within

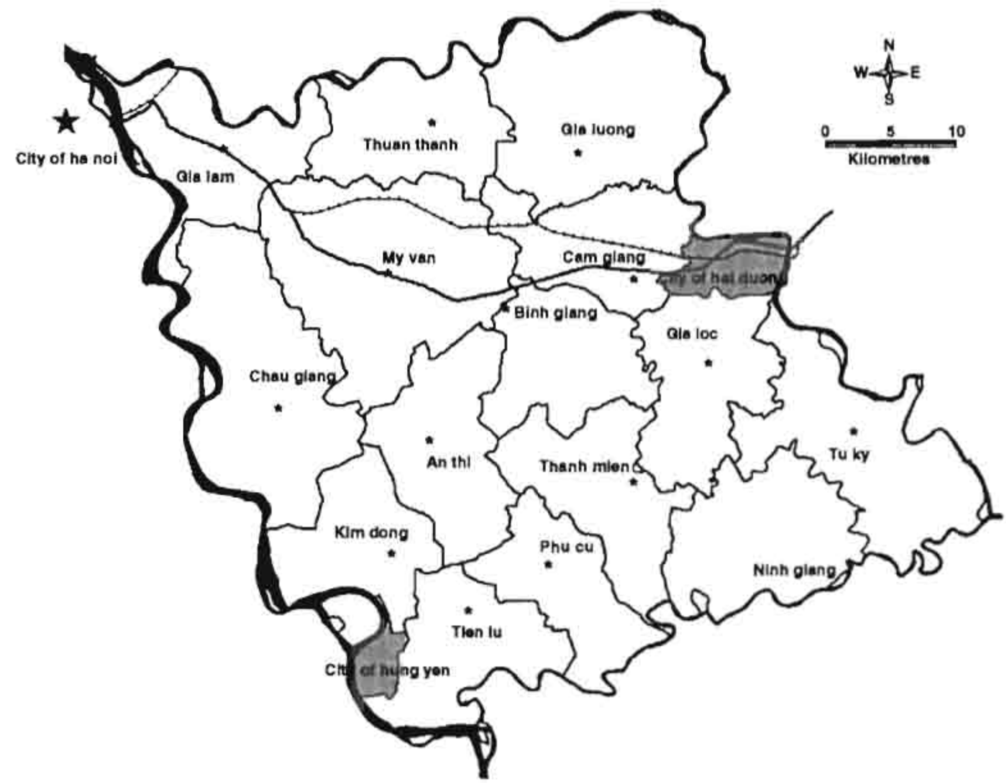

Fig. 7.2. The Bac Hunh Hai polder and administrative boundaries.

this ministry is responsible for the planning, design, construction and funding of major irrigation projects larger than 150 ha. It fixes the national guidelines for the calculation of the water fee according to the type of irrigation (gravity, one or two pumping operations) and drainage (gravity and/or pumping).

The responsibility for managing existing public irrigation and drainage systems, and planning and executing smaller projects is delegated to the province under the leadership of the Provincial People's Committees (PPCs). The PPCs provide policy advice and funds and oversee the work of technical services, set provincial water rates based on national guidelines, allocate subsidies for local water resources projects, and make investments in local infrastructure. The provinces have established Water Resource Services (WRS) to handle these water-related responsibilities. There are ten WRS involved in the water management of the Red River delta, since the delta overlaps ten provinces. WRS are line agencies of the provincial governments. Their duties are similar to those of the central Department of Water Resources in terms of planning, design and construction, but are focused on smaller projects below 150 ha.

Additionally, they shoulder the responsibility of calculating water fees paid by farmers, in consultation with PPCs and the party bureaucracy, and oversee the District Enterprises (DEs), which operate irrigation systems within polders. Water fees and their calculation were originally based on a national decree that the government cabinet promulgated in August 1984 (112 HDBT, 1984). Following national policy, the total water fee cannot exceed 8% of each province's average paddy yield for the last five consecutive seasons, for spring and summer seasons. The fee calculation is based on three subsidiary fees which correspond to rice nursery irrigation, paddy field irrigation and paddy field drainage operating costs. The maximum value of the fee for these different services depends on whether water is supplied by gravity, or through one or two pumping operations: the irrigation fee, for example, includes a 'diversion' fee which is paid to the company in all cases (operation of the main system), a pumping fee if such an operation is necessary and a field application fee. The diversity of situations leads to a great complexity in the calculation of the fees. Even though farmers now generally pay in cash, the fee is expressed in kilograms of paddy, and the PPCs determine every year an official rate for 1kg of paddy in order to insulate the calculation of the fee from the price fluctuations in the paddy market.

IDMC at the polder level

IDMCs are provincial state companies established under the WRS to identify and design water resource projects, to construct and repair civil works and to manage irrigation water. Most often, an IDMC has responsibility for all existing public irrigation in a primary hydraulic unit (or polder). Several IDMCs can respond to the same WRS when the province encompasses more than one polder. Unlike the Department of Water Resources and WRS, the IDMC level is not based on an administrative division but on the polder division. There are 30 IDMCs in the delta, managed by 10 provincial WRS (Fig. 7.3). In larger polders, which extend over more than one district, the IDMC is assisted by several subcompanies[10] (otherwise known as District Enterprises or DEs), one per district concerned. In 1995, 14 DEs were recorded in BHH, the largest polder in the delta.[11] Each IDMC or DE is structured based on irrigation stations, called *cum*, each of these being responsible for approximately 1000ha. Hydraulic cum work with an average of 3–5 cooperatives to manage water, maintain facilities and collect the water fee. Hydraulic cum are responsible for the O&M of schemes, from the pumping station to the secondary canal.[12] Overall, the mismatch between hydraulic units (polders, irrigation units) and administrative ones (province, districts, communes) generates a complex set of nested structures. Management practices, financing and accountability will have to be defined at all levels and made compatible.

With the 1997 national Directive 56/CP, IDMCs (and DEs) were transformed into public utilities. They were expected to cover the costs of water diversion, O&M of irrigation and drainage and depreciation, through the collection of the water fees paid by the farmers. However, IDMCs do not have control over their income and are, in particular, not allowed to raise service fees or keep surplus funds, except for minimal maintenance. In case of climatic hazards, such as typhoons and droughts, state subsidies are supposed to be granted in order to compensate for extra drainage and field application costs, while water fees are reduced in case of paddy losses from flooding. Implementing Directive 56/CP is the responsibility of each PPC, which adapts the directive to its own situation and issues provincial circulars on this issue.

The DEs are normally responsible for the main pumping infrastructure located at the head of the main canals and for operating the main drainage stations within an irrigation system (usually a large sub-polder). The DEs are nominally district-level organizations, but in practice they may often cover multiple districts within one province. The IDMC operates the main hydraulic infrastructure on the river system and the DEs, which are owned by the individual provinces, pay a bulk water fee to the IDMC. At Bac Hung Hai, the DEs tap water from, and discharge it into, the natural channel and

[10] In the case of BHH, this distinction is important since the DEs are managed by the individual provinces, but the IDMC is managed by a consortium of provinces and the MARD centre: the Director of BHH does not report to the provinces but to MARD, and is in fact usually in conflict with the provinces over the payment of bulk service charges by the DEs.

[11] The two districts of Bac Ninh province have a joint DE. This is why there are only 14 DEs for 15 districts in the BHH polder, which overlap with four different provinces (Fig. 7.2).

[12] Their formal responsibility ends at the tertiary turnout, which is where the responsibility of the cooperatives' water management groups begins. However, in practice, the cooperatives often control the secondary channels and even sometimes control the operation of the secondary head gates, but this usually brings them into conflict with the company and the *cum*.

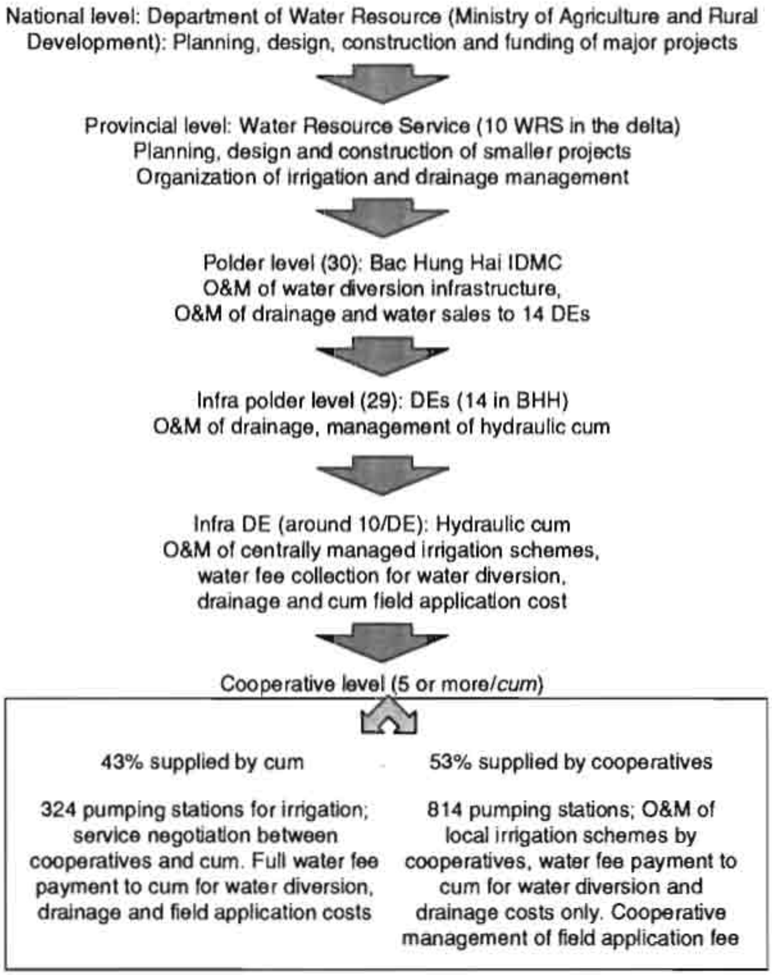

Fig. 7.3. Water management organizational framework in the Bac Hung Hai polder.

main canal network, which is operated by the BHH IDMC. Where the IDMC operates only within a province, payment of bulk water charges is enforced by the Provincial WRS (and the Economic Court) and it has not been a major problem. However, in BHH, the IDMC was jointly owned by four provinces and was then taken under the Ministry's jurisdiction because of financial losses amounting to around $1.00 million per annum over the period 1994–1998. Underpayment of bulk water charges by DEs has been a significant contributing factor to this situation, and it is still unresolved.

Because of the size of the BHH polder, BHH IDMC constitutes a special case: before 1998, it was supervised by the Hai Hung provincial WRS.[13] Nowadays, BHH IDMC is supervised by a System Management Council, constituting representatives from the four provincial WRS concerned, and chaired by the Director of the Department of Water Resources. BHH IDMC is responsible for water diversion and transportation from the river through the dual-purpose central canal network on the whole BHH polder, and for

[13]The Hai Duong and Hung Yen provinces formerly formed the Hai Hung province. The 1997 reform led to the division of several provinces and districts in Vietnam and resulted in the BHH overlapping with four provinces.

the operation of most tail-end drainage facilities (pumping stations and gravity gates) which discharge outside the dykes of the BHH polder.

Within the BHH polder, the situation of each district depends on the province it belongs to: the DEs from Hung Yen and Hai Duong provinces (which make up 85% of the BHH-supplied area: Fig. 7.1) pay, based on actual supplied area (36 kg/ha for the spring season and 24 kg/ha for the summer season), while DEs of Hanoi and Bac Ninh provinces pay a percentage of BHH IDMC annual expenditures equivalent to the share of area covered by each DE (3% for Hanoi DE and 12% for Bac Ninh DE). Table 7.1 indicates the breakdown of revenues and expenditures of the IDMC as dictated by the national regulation and its evolution in the Hai Duong province after decentralization measures started to be enacted.

Table 7.1. Annual revenues and expenditures of IDMCs and DEs in the Hai Duong province.

		National regulation	Hai Duong provincial regulation
		Circular 90/1997/TTLT/TC-NN	Decision 1854/1998/QD-UB
Incomes	Water fee average level	From 3% to 8% of the yield Directive 112/HDBT (1984) Circular 90/1997/TTLT/TC-NN (1997)	From 1.6% to 5.9% of the yield Decision 1132/QD-UB (1993) Decision 283/QD-UB (1998) - when yield decreases >30%
	Public subsidies	- when yield decreases >30% - when income < expenditures (from national budget) - when drainage cost > average ratio kWh/ha	- when income < expenditures (from national/provincial budget) - when drainage cost > average ratio kWh/ha - permanent subsidy to decrease water diversion cost to farmers
	Commercial activities	Directive 112/HDBT (1984)	Directive 112/HDBT (1984)
	Gasoline and electricity	<50%	Circular 16/DM-XN (1989)
	Salaries	<8% of total expenditures Circular 06/NNPTNT (1998)	<8% of total expenditures Circular 06/NNPTNT (1998)
Expenditures	Social and health insurance	19% of salaries Directive 112/HDBT (1984)	19% of salaries Directive 112/HDBT (1984)
	Diversion cost paid to BHH IDMC	Directive 112/HDBT (1984)	Decision 1132/QD-UB (1993)
	Depreciation of equipment	Decision 1062TC/QD/CSCT (1996)	Decision 1062TC/QD/CSCT (1996)
	Exceptional repairs	18–20% Decision 506TC/DTXD	16–19% Circular 06/TL (1990)
	Ordinary repairs	20–30% Decision 211/BNN (1988)	14–16% Circular 06/TL (1990)
	Water fee collection	2–3%	<3%
	Management overheads	5–6%	<5%

Regarding public subsidies, the Hai Duong provincial decision No. 283/QD-UB stipulates that altogether 136,000 kWh are annually needed to cover the electricity costs of drainage stations. When drainage needs are higher than this rate, subsidies are granted by the provincial WRS (no longer by the finance ministry) to the IDMC to compensate for the losses. Moreover, a permanent (but small) subsidy is given to the IDMC to decrease the cost of water to farmers. Finally, commercial activities also contribute to the company's income. They include transport fees for boats using the primary canal network, and the maintenance fees for the main works directly carried out by the company. An analysis of the period 1995–1999 showed that, on average, diversion fees paid by DEs amounted to 87% of the BHH IDMC annual revenue, while subsidies and commercial fees represented only 2% and 11%, respectively (Nguyen Thi Hong Loan, 2000). Table 7.1 also specifies expenditures in terms of percentage of the revenue. The larger share goes to maintenance work, while salaries plus health-care costs have to remain approximately below 10%.

Cooperatives and farmers

Cooperatives[14] are the lowest formal administrative level involved in irrigation and they are collective bodies supposed to represent all the farmers who depend on their agricultural services now mainly concentrated on water and electricity. They are managed by commune officials only, and access to membership (with corresponding rights) is restricted to volunteer farmers (members of the Party or of the Farmers Association). The relationship between cooperatives and DEs, via a hydraulic cum, depends on the existence and the location of local pumping stations. Every year, each cooperative signs a service contract with a cum, which acts on behalf of the district. These contracts are established on a seasonal or annual basis by mutual agreement and signed between each cooperative director and the staff in charge of the cum, or by the DE's director directly. The contract specifies the seasonal or annual water fee to be paid by the cooperative. For the spring season, the area cultivated by the cooperative is indicated and the supplier specified: water can be either provided by the cum or by a local pump of the cooperative itself. For the area to be supplied by the cum, more details are given: these include the kind of crop (rice, rice nursery, food crops or industrial crops), and the kind of irrigation, which is provided (direct gravity irrigation, single or double pumping, 'hand lifted' irrigation). For each type of crop and irrigation, a water fee rate is given in kilograms of paddy per hectare, based on provincial regulations. These rates are multiplied by the area of each type of crop and irrigation, and then aggregated. The sum gives the amount of irrigation fee, including the water diversion costs, to be paid by the cooperative to the cum. For the summer season, an additional fee for drainage is calculated on the basis of the whole area cultivated by the cooperative. The date, place and nature of payment are specified too. Contracts vary according to the water-supply situation of each cooperative, as explained below:

- When there is no local pumping station, cooperatives are responsible for distribution of water and maintenance of irrigation canals, from secondary canals to quaternary canals. They collect a water fee from farmers, which is equivalent to water diversion, drainage and field application costs. Of the fee, 98% is paid to the hydraulic cum, which supplies them with water, and 2% is kept by the cooperative for field-level water management.
- When there are local pumping stations built along one of the channels of the polder, cooperatives have to operate and maintain their system from the pumping station down to the quaternary canals. They collect a fee from farmers as explained above but they do

[14]Cooperatives are established at the commune or village level. In the latter case, the village cooperatives are subsidiaries of the Economic Development Committee of the commune. In any case, cooperatives are closely linked to commune authorities.

not pass the total on to the cum. They only pay for water diversion and drainage costs and keep the irrigation fee (adjusted so as to incorporate the cooperatives costs) for themselves.

- When there are local pumping stations that withdraw water from primary (raised) irrigation canals supplied by a pumping station of the cum, cooperatives have to operate and maintain their local systems from the local pumping station to the quaternary canals. The field application fee is increased, since some of it is kept by the cooperative to cover the cost of its own irrigation pumping operations, while the standard fees for diversion, drainage and field application are paid to the cum.

Some cooperatives are fully independent while others still rely on centrally managed pumping stations for a percentage of their irrigated area, ranging from a few hectares to the whole cooperative-irrigated area. Combinations of two of these three cases can also be found within the same cooperative, as sub-areas may have different statuses: in such cases, the costs of supplying water to farmers differ but they are averaged in order to come up with a uniform fee per hectare. In the BHH polder, there are only a few cases of double pumping which are not recorded in DE's statistical data. The official figures indicate that 53% of the BHH irrigated area is supplied by cooperative stations and 43% by DEs (Table 7.2).

Finally, farmers have to pay part of their annual individual water fee to the cooperative twice a year, after spring and monsoonal rice harvests. The amount they pay reflects the situation of the cooperative regarding irrigation and drainage facilities. They all pay the same amount per unit of area, irrespective of the location of their plots. The water fee is paid together with other levies such as the land tax and several local taxes established by the commune (maintenance of local roads, field surveillance, taxes on houses, gardens and ponds, solidarity tax, etc.). As a result, only a few farmers know the exact amount paid for the irrigation and drainage service (Fontenelle and Tessier, 1997).

Table 7.2. District area supplied by DEs and cooperatives in the spring, 1996.

District	DE (ha)	Cooperative (ha)	Total (ha)	DE (%)	Cooperative (%)
Gia Lam[a]	1,665	132	1,892	88	7
Thuan Thanh	4,312	1,761	6,073	71	29
Gia Loc	3,796	3,367	7,163	53	47
Chau Giang	4,934	2,129	9,675	51	22
An Thi	3,238	3,651	6,889	47	53
My Van	5,391	6,094	11,719	46	52
Tien Lu	2,061	2,733	4,794	43	57
Thanh Mien	2,642	4,499	7,141	37	63
Kim Dong	1,547	2,749	4,296	36	64
Cam Giang	1,877	3,338	5,215	36	64
Gia Luong	3,282	6,094	9,376	35	65
Phu Cu	1,671	3,244	4,915	34	66
Binh Giang	1,492	4,245	5,737	26	74
Tu Ky	1,949	5,196	8,119	24	64
Ninh Giang	1,633	5,255	7,101	23	74
Total BHH	41,490	54,487	100,105	43[b]	53

[a]Cooperatives outside BHH polder are not taken into account.
[b]The total does not amount to 100%: a 4% difference is due to missing data.

The Intricacies of Water Pricing

Overlapping rationalities

The emergence of local pumping-irrigation stations in the Red River delta led to the creation of a dual system where two kinds of irrigation stations, with different technical characteristics, supply fragments of the same original network. In the BHH, there were 814 local stations in 1996 supplying 54,487 ha, and 324 centralized stations supplying 41,400 ha. Figure 7.4 provides the example of Van Giang DE, which includes four cum (the average size of local schemes, 67 ha, is, therefore, half that of the present (reduced) size of centralized schemes, 128 ha). Local pumping stations had a higher per-hectare pumping capacity than centralized stations when they were constructed (Table 7.3). Their investment cost per unit area is higher but, on the other hand, they provide several benefits to farmers (Fontenelle and Tessier, 1997; Mai Van Hai, 1999) as listed below:

- *Satisfaction of water requirements.* Technical surveys conducted on irrigation efficiency at scheme, plot and field levels in the An Binh cooperative, in the Nam Thanh district, showed that crop water requirements were met. This contrasts with the former situation of centrally managed stations where downstream cooperatives could not access water in time (Bousquet *et al.*, 1994; Dang The Phong and Fontenelle, 1995).
- *Flexibility/autonomy.* Field surveys conducted in 13 communes of the Nam Thanh district have shown that farmers did not want an irrigation interval longer than 7 days (Dang The Phong and Fontenelle, 1997). On local irrigation schemes, there is no delay between the decision to pump and the arrival of water. During the rice season, the full supply by local irrigation units is achieved within a day. Farmers can now complete their land preparation within 2 days, instead of 11, as earlier, which allows them more flexibility in terms of

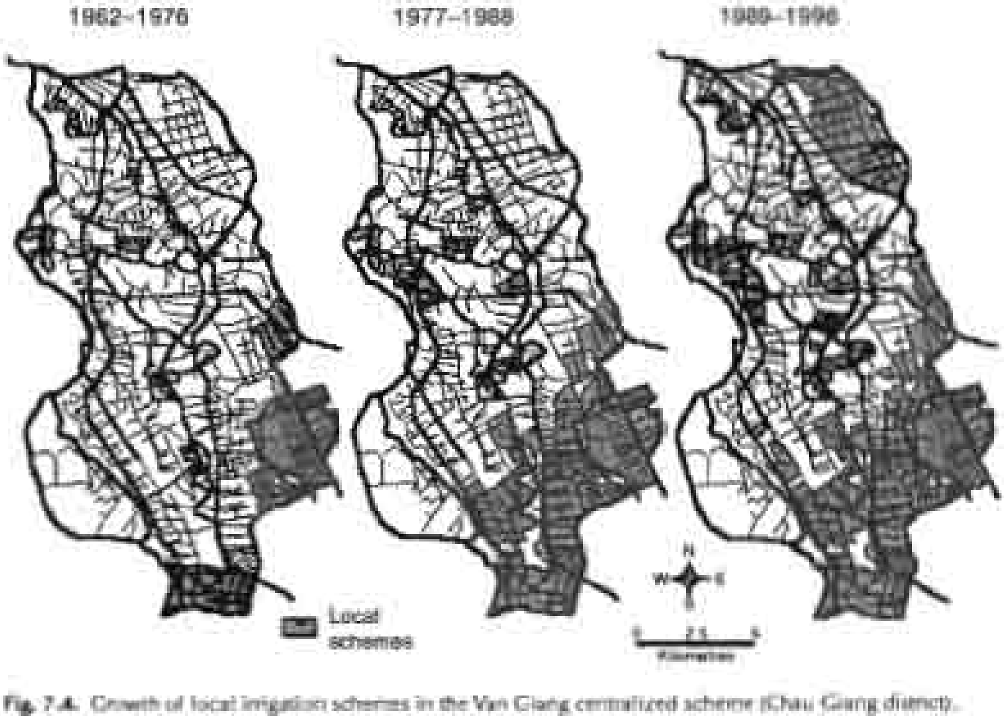

Fig. 7.4. Growth of local irrigation schemes in the Van Giang centralized scheme (Chau Giang district).

Table 7.3. Comparison of irrigation duration for local and centralized stations.

	24h–average	Land preparation	Rice-season irrigation
	Continuous flow	Supply of 100mm (night and day, 20h)	Supply of 30mm (12h maximum per day)
Local station	7.0l/s/ha	40h: 2 days	12h: 1 day
Centralized station	1.2l/s/ha	231h: 11.5 days	69h: 6 days

Table 7.4. Average volumes pumped per hectare during spring season 1996.[a]

	Land preparation (m^3/ha)	Rice-season irrigation (m^3/ha)	Seasonal consumption (m^3/ha)
Local station	1600	2400	4000
Centralized station	3900	5900	9800

[a]Monitoring of ten pumping stations in the Nam Thanh district, Hai Duong province. Rainfall during the spring season is 405mm on average. For more information on field water balance in the Red River delta see Dang The Phong and Fontenelle, 1995.

cropping patterns and choice of rice variety. The cooperatives' decisions to pump are triggered by the actual water status in paddy fields and not based on a fixed pumping calendar. Managers and users of local schemes are from the same village, or even from the same hamlet. They define their water supplies and rules among themselves, without DE intervention. Localities commonly share irrigation benefits and constraints within their boundaries, as it was the case before the agricultural collectivization of the 1960s (Fontenelle, 1998, 1999).

- *Efficiency*. The design command area of local schemes is smaller than in centrally managed schemes, below 100ha instead of 1000ha or more.[15] Canals are shorter and less water is wasted compared with centrally managed schemes, which suffer from water losses and illegal water diversions (Bousquet *et al.*, 1994; Fontenelle, 1999). As a result, local stations pump less water per unit of irrigated area than central ones, as can be seen from Table 7.4.[16] Differences in water use are due, in part, to the fact that local management is more efficient, but higher per-hectare consumption rates of companies are also due to some illicit arrangements between cooperatives and staff of cum pumping stations. In some instances, staff of pumping stations 'sell' water to cooperatives (which under-report their irrigated areas) in order to increase their income. This increases the total volume delivered per hectare, which puts further pressure on the DE to balance its books, since it cannot revise the charges per unit area.

However, reasons for investing in local pumping stations are not technical only. First, before the end of the 1980s, it was a way to justify and obtain the electrification of a village (*thon*) or a commune (*xa*) (Do Hai Dang, 1999). Second, the establishment of a local pumping station in

[15]The original area of the centrally managed Van Giang scheme was 14,000ha.

[16]These values are based on two combined approaches. One consisted of the monitoring of date and duration of each pumping. The other consisted of power readings. In both cases they represent actual volumes pumped and do not represent billed amounts.

each village of a commune is sometimes the sign of political competition between influential persons (*notables*), who all want to have a local station serving their village. Effective continuous flows of 5 l/s/ha may be technically acceptable but they sometimes reach 10 l/s/ha, which are clearly unnecessary as far as paddy cultivation is concerned. Beyond the mere technical question of crop water supply, local water management and investments embody local competition for prestige and power political struggles among commune and village leaders.

Costs to farmers

To assess the cost of water to farmers, six cooperatives were surveyed in two districts of the BHH. Two were fully responsible for their irrigation and two others partly responsible, while the last two were supplied by the central pumping stations of the company for all their irrigated area (Table 7.5). Results show that when pumping stations are managed by the cooperatives themselves, the calculation of the water fee can be based either on actual costs paid by the cooperatives or on fixed rates chosen by each cooperative. When the water supply to the cooperative depends on central stations the water fee calculation is based on provincial regulations only.

Table 7.6 specifies the amount of water fees paid by farmers and shows significant differences between cooperatives. These can be due to the natural or hydraulic conditions of each cooperative, such as the necessity of double pumping in the Tan Lang commune. But differences should not appear within each type of water supply, since rates are based on the same provincial directives and national decrees. For instance, single pumping fees range from 395 to 473 kg/ha/year in the same province of Hai Duong (cf. Table 7.6), which is 'officially' impossible. The highest levy was paid by farmers from the Tan Lang cooperatives, where all irrigated areas are supplied through two consecutive pumping operations. It amounted to 639 kg of paddy per hectare per year (paddy/ha/year). The lowest fee was paid by farmers from the Hung Thai cooperative, in which water supply of all types was cheaper than in other surveyed cooperatives. For example, a

Table 7.5. Irrigation type and water fee calculation system for six surveyed cooperatives.

Name of the cooperative	Scale	Number of pumping stations	% of the area supplied by local stations	District	Province	Basis of fee calculation
Tan Vinh	Village (since 1982)	2	100	Ninh Giang	Hai Duong	Cooperative effective expenditures (CEE)
Tan Lang	Commune	9	100	Gia Luong	Bac Ninh	Cooperative fixed rates (CFR)
Hung Thai	Commune	3	61	Ninh Giang	Hai Duong	Provincial fixed rates (PFR)
Dong Tam	Commune	3 (+ 4 + 12)[a]	60[b]	Ninh Giang	Hai Duong	CEE for pumping and PFR for water diversion
Ngo Phan	Village (since 1992)	0	0	Gia Luong	Bac Ninh	Provincial fixed rates
Kim Thao	Village (since 1987)	0	0	Gia Luong	Bac Ninh	Provincial fixed rates

[a]There are four local collective diesel pumping stations and 12 individual petrol pumping stations for 28% of the total cooperative area.
[b]Including the 28% supplied by diesel and petrol pumps.

Table 7.6. Water fee paid per type of water supply (in kg of paddy/ha/year).

Name of cooperative	Type of access to water existing within the cooperative: Single pumping	Double pumping (DE + Local)	Diversion by gravity	Remarks
	Total (company + cooperative)			
Tan Vinh	619 (473 + 146)	–	324 (178 + 146)	Including 146kg of extra fee for maintenance and new construction
Tan Lang	–	639	–	
Hung Thai	464 (408 + 56)	345 (289 + 56)[a]	253 (197 + 56)	Including 56kg of extra fee for maintenance and new construction
Dong Tam	478 (395 + 83)	–	280 (197 + 83)	Including 83kg of extra fee for maintenance and new construction
Ngo Phan	475	475	475	Fee averaged for all, for simplicity and equity concerns
Kim Thao	586 (475 + 111)	–	–	Including 111kg of extra fee for maintenance and new construction

[a]In fact, in this cooperative there is only one pumping from the DE. The second lift is done manually by farmers.

single pumping operation by a local station costs farmers 464kg of paddy/ha/year in the Hung Thai cooperative, which is 28% cheaper than in the Tan Lang cooperative.

But beyond these differences between cooperatives, another difference is introduced by local extra water fees defined, collected and used by cooperatives to improve the quality of their service (extra costs for local maintenance) and to develop their capacity (capitalizing for new investments in local stations). Extra fees, also referred to as 'exceptional levies', range from 56 to 146kg/ha, i.e. between 12% and 45% of the total fee.

These differences are a manifestation of their autonomy but they also create a degree of inequity among farmers, who do not benefit from the same production conditions depending on the cooperative they belong to. However, compared with the annual production of paddy (an average of 8 t of paddy in two seasons, plus an additional crop in one-third of the area), water fees appear to be quite small. Even in the Tan Lang cooperative, they do not exceed 8% of the annual paddy production (not considering the benefit of the winter crop). In most areas of BHH water can be supplied by a single pumping operation. Therefore, water fees paid by farmers in these cooperatives (including extra fees established by cooperatives) range from 5.8% to 7.7% of their annual paddy production, which is reasonably expensive.

The point is that most farmers do not know the details of the calculation of the water fee. This information is withheld by the village chief who is in charge of tax collection on behalf of the Commune People's Committee, and downward accountability linkages are weak (Small, 1996). Ambiguity also results from the complexity of the breakdown of the water fee, depending on local conditions and is further strengthened by the fact that land taxes are usually assessed and collected at the same time. Farmers only know how many kilograms of equivalent paddy they have to pay at the end of each rice season, and even if they know the amount of the water fee they are not in a position to ascertain whether the extra fees collected are justified or not and what their exact utilization is (Fontenelle and Tessier, 1997). Sometimes, there is an ambiguity between irrigation services and the provision of electricity to households, which also allows some illicit gains to the cooperatives.[17] All this lack of clarity is embedded in kinship and patronage relationships and tends to engender mistrust in the villages (Do Hai Dang, 1999). Altogether, the annual taxes paid by farmers amount to 20–25% of the value of the annual paddy production (Bousquet *et al.*, 1994). They include not only the water fee but also the land tax and several other taxes (house, field watching, cooperative fund, construction of local roads, health, labour insurance, construction, crop damages, 'solidarity tax' for pioneer settlements or solidarity with Cuba, and the police). More than an issue of only taxation, farmers' difficulties are due to the low economic return of paddy production. Production costs (not considering labour and water fees) amount to 25% of the annual gross value of paddy production. Added to the water fees and other taxes, almost 50% of farmers' annual gross paddy production value evaporates.

The cooperatives: balanced but non-transparent accounts

The financial situation of the cooperatives surveyed was analysed using data communicated by the cooperatives themselves, except for the Kim Thao village cooperative, where information was not made available (Table 7.7). On the basis of the available information, it appears that the breakdown of expenditures varies from one cooperative to another.

The number of staff is obviously larger in commune cooperatives than in village cooperatives but it seems that there is no economy of scale as the share of management costs is higher in the former than in the latter. With the available information, it is difficult to interpret correlation between this share and the degree of dependence on the company. The amount paid to the DE is directly correlated to the percentage of area supplied by the central pumping stations, ranging from 30% (100% locally irrigated) to 75% (100% centrally irrigated) of total costs. On average, repairs amount to 15% of total expenditures, and investment in new construction or savings for depreciation of the equipment are not frequent. With the exception of the Tan Lang cooperative, and on the basis of the available values, cooperatives seem to balance their accounts, which are not the cases of IDMCs and DEs, as will be shown later. The main point about these values is that no justification is given for them. Cooperative managers do not present their accounts with more detail than the data provided in this table. Moreover, in three of the surveyed cooperatives no information was provided on the amount of fees collected. Financial transparency is not the rule.

IDMC's finances

The analysis of annual fee recovery of BHH IDMC and four DEs showed a cumulative financial deficit. Table 7.8 first illustrates the situation encountered in four DEs, one from each of the provinces overlapping the BHH polder for four consecutive years. These included Ninh Giang DE from the Hai Duong province, Chau Giang DE from the Hung Yen province, Gia Lam DE from the Hanoi province and Gia Thuan DE from the Bac Ninh province.

The water fee collected annually by each of these four DEs never reached the expected income, but fee recovery from the cooperatives nevertheless exceeded 92%,

[17]The electricity for pumping (irrigation) is billed 30% cheaper than domestic electricity by the company in charge of this service. The cooperatives sometimes apply only the higher tariff to all types of consumption.

Table 7.7. Annual water management average expenditures and balance (years 1998 and 1999).

Name of cooperative	No. of staff	% Management costs	% Paid to DE	% Electricity	% Repairs	% Invested	% Depreciation	% (Income – expenditures)/ incomes
Tan Vinh	9	9.7	30.1	11.5	18.7	30.0	0.0	+7.3
Tan Lang[a]	27	9.3	29.1	44.4	17.2	0.0	0.0	–81.4[b]
Hung Thai	17	23.0	43.6	18.8	11.9	0.0	2.7	+4.0
Dong Tam	32	29.9	50.0	12.5	7.6	0.0	0.0	+2.5
Ngo Phan[a]	9	5.9	74.8	0.0	19.3	0.0	0.0	–0.8

[a]Average on 1997, 1998 and 1999.
[b]Electricity costs are much higher for this cooperative because of double pumping.

Table 7.8. Water fee, incomes and expenditures (DE).

DE	Year	Water fee (in billion dong[a])		Incomes	Expenditures		Cost/ income
		Due	Collected	%	(in billion dong)	(in billion dong)	%
Ninh Giang	1996	3.0	2.9	97	3.0	3.5	117
(Hai Duong	1997	2.5	2.4	96	2.9	3.6	124
province)	1998	2.7	2.4	89	3.0	3.3	110
	1999	2.3	2.2	96	2.9	?	?
Chau Giang	1995	2.4	2.4	99	2.6	2.7	104
(Hung Yen	1996	2.6	2.4	92	2.6	3.1	119
province)	1997	2.1	2.1	98	2.2	2.6	118
	1998	2.8	2.7	96	2.8	3.3	118
	1999	2.5	2.5	97	2.7	3.2	119
Gia Lam	1995	2.5	2.2	88	2.5	3.0	120
(Hanoi	1996	3.2	3.0	94	3.0	3.6	120
province)	1997	3.2	2.8	88	2.8	4.3	154
	1998	3.1	2.6	84	3.3	4.3	130
	1999	3.9	3.2	82	3.7	4.1	111
Gia Thuan	1995	6.7	6.3	94	7.9	6.7	85
(Bac Ninh	1996	8.4	7.4	88	11.0	9.5	86
province)	1997	7.1	6.5	92	8.1	11.5	142
	1998	8.0	7.4	93	9.0	11.5	128
	1999	8.1	7.7	95	9.1	11.0	121
Average	5 years			92			118

[a]Note: $1.00 = Dong 15,980.

which is quite remarkable.[18] However, this is partly achieved though the manipulation of areas and income to be able to report such a recovery rate. The analysis of the annual effective expenditures compared to annual effective incomes (fee + subsidies + commercial activities) shows that the situation of the DEs is really unbalanced, with expenditures exceeding incomes by 18% on average (Table 7.8).

[18]The reasons for defaulting are not clear. It is possible that cooperatives which receive poor services decide to withhold part of the fee. Since these figures come from the DEs, it is also possible that these have interest in showing a shortfall. Interestingly, there is a recent move towards establishing contacts between the cum and the cooperatives which are not based on area but on real pumping hours and days. The gains, however, may not reach farmers as they are unaware of the nature of the contracts.

Table 7.9. Cumulative debt of four DEs (up to 1999, included).

	Ninh Giang (in million dong)	Chau Giang (in million dong)	Gia Lam[a] (in million dong)	Gia Thuan (in million dong)
Electricity cost	116 (17%)	1349 (58%)	1126 (61%)	1754 (41%)
BHH water diversion fee	444	968	697	1975
Other (repairs, maintenance, etc.)	141	0	25	517
Total	701	2317	1848	4246
In percentage of annual income	24	90	60	47

[a]These figures account for the totality of the Gia Lam district (communes inside and outside BHH included).

This situation is due to the incapacity or unwillingness of the provinces to provide subsidies to compensate for the loss, as dictated by the regulation. The shortfall thus corresponds to debts incurred with BHH IDMC and electricity companies, as specified in Table 7.9. On average, the cumulative debt of these companies exceeds 55% of their annual income, with important differences from one company to another. The status of each company is strongly correlated to the importance of the cumulated electricity debt rather than to the BHH water diversion fee, which amount is known by each DE and does not vary much from one year to the next. This does not apply to electricity costs, which depend on annual rainfall and farmers' practices. These differences between incomes and expenditures show that the present regulation does not allow the financial equilibrium of the activities of companies without the provision of subsidies by the national or provincial levels, and the granting of loans by the banks.

A similar analysis was done for BHH IDMC. Table 7.10 shows that for the 5 years studied the company could not collect the full water diversion fee owed by the 14 DEs. The fact is that DEs do not pay their diversion fee to the BBH IDMC as they should (80% at the most).

This financial imbalance has a direct impact on BHH IDMC activities. Every year, the company has to submit its activity plan to the authorities. Priority is given to operational activities to the detriment of maintenance and repairs. Financial resources cover priority costs, such as salaries for IDMC staff, electricity and petrol for station operations, costs of water fee recovery and interest on loans. Maintenance and repair activities depend on the annual collected income, on cash flows and loans made with public organizations (banks and public companies). Figures for major repairs show that differences between planned and achieved activities are very large every year (see Table 7.11). It was only in 2 years, 1996 and 1999, that the company could mobilize enough funds to cover the cost of the planned repairs. This is because, in 1996, BHH IDMC got a loan of 3.7 billion dong from

Table 7.10. Comparison between due and collected water diversion fee (IDMC).

Year	Water diversion fee due (in billion dong)	Water diversion fee collected (in billion dong)	Percentage
1995	7.6	4.4	58
1996	8.4	6.7	80
1997	7.4	4.3	58
1998	11.1	6.1	55
1999	9.2	6.6	72

Table 7.11. Comparison between planned and achieved main repairs (BHH IDMC).

Year	Main repairs planned (in billion dong)	Main repairs achieved (in billion dong)	Percentage
1995	3.7	1.6	43
1996	3.4	3.7	109
1997	3.2	1.5	47
1998	3.8	0.9	24
1999	2.9	3.2	110

the dredging (public) company and in 1999 it got a subsidy from the Ministry of Agriculture and Rural Development. This shortfall in income weakens the capacity of the IDMC to meet its annual O&M costs.

Institutional contradictions and difficulties

From a functional point of view, the relevant unit of an irrigation scheme is the hydraulic unit. But decisions on water management (and, in a large part, on financial issues) are based on administrative decisions and on administrative units. This is a classical problem with irrigation schemes which also applies to the IDMCs and DEs, which are under control of the Water Resource Services of the province. Moreover, some IDMCs, as was the case in the BHH polder, are under the control of more than one province. When water is provided to hydraulic units that span different provinces, the level of fees and subsidies can be different for the same service. Currently, there are four different directives governing the level of the water fee paid by farmers living in the BHH unit, and policies on subsidies vary from one province to another. This situation leads to inequity in water fees paid by farmers, depending on the province they belong to.

The level of fees is determined by People Committees, under an overall framework fixed by the state. They are based on a percentage of the yield, depending on the kind of water service that is provided. At national and even more at provincial levels, the determination of fees is based more on political considerations than on the economic analysis of water service costs. For example, the level of fees did not follow the huge increase in electricity costs which took place between 1986 and the early 1990s.

The companies have limited control over their income, which depends on the area actually irrigated and drained, and on the level of the fees. Even if they collected 100% of the fees, Table 7.8 suggests that only half of their deficit would be covered. Officially, provincial subsidies are supposed to cover the differences between income and expenditure. Moreover, the reference for the fees is supposed to be the average yield for the past 5 years. But often, this reference has not been revised since 1984, even if real yields have dramatically increased. In addition, provincial WRS did not add a third irrigation fee for the winter-season crop, even when some irrigation supply was required. Instead, they decided that the cost of the third crop would be covered by subsidies as a political measure to promote intensification of agriculture. This makes DEs reluctant to supply water in winter, which encourages farmers to develop their own pumping schemes. Considering the actual agricultural production (paddy yields and a third winter crop) of farmers, the effective water fee they pay to the companies is lower than the maximum nominal official percentage (5.9% of yield for Hai Duong).

The main operating costs of companies are electricity and maintenance, along with salaries. The electricity bill depends on the year (and especially on the amount of drainage pumping done) but companies have to meet it even if they jeopardize their annual financial balances, for fear of occasional power cuts. They cannot stop drainage or irrigation when the electricity expenses are above the provisional budget. Most company charges are defined and fixed by the administration. Decrees on water management specify how many people have to be employed for each kind of work. Depending on its power, a pumping unit must have a head, a worker and, maybe, a third person. Therefore, the number of persons working for the company is broadly defined by the structure of the scheme. Some officials at the central level say that these norms are too high and that it is not necessary to have so many persons. Salaries, social security contributions, etc., are also fixed by the administration. Even if they wanted to, companies could not significantly reduce the cost of labour. This cost, in all instances, if we trust official statistics, remains under 10%. It is not as high as expected but might reflect employees' very low salaries. Thus, it would be unfair to assimilate these companies to overstaffed agencies commonly found in the irrigation sector, and reducing staff would only yield very limited gains.

In such a situation, companies can only control their expenses by deferring or leaving the maintenance works unpaid. Moreover, for patronage or political reasons, companies may employ more persons than the number fixed by decrees. Most of the maintenance work is done by the companies themselves, or by public enterprises under contract without real competition, which may result in increased costs.

Due to the emergence of local pumping stations, DEs now supply only about 50% of the area they served originally. Their incomes are based on the area supplied and have therefore significantly declined, but the amounts in electricity bills have also decreased because of the smaller area now serviced. Electricity, however, is only one part of the expenses, and labour or other fixed costs have not decreased, because the number of persons paid by companies remains the same. Moreover, the contract between companies and cooperatives is based on an estimate of the irrigated and drained areas, but companies are not able to accurately determine the effective area. Cooperatives tend to under-report this area as a way to reduce the fee paid to the companies, contributing to widening the gap between DE incomes and costs.

The evolution of the legal status of DEs has constituted a significant step in the restructuring of water management after de-collectivization. Compared with a fully centralized management, it allows a better specification of responsibilities. The attempt to oblige DEs and IDMCs to balance their budgets, however, was a failure, despite efforts by DEs to improve fee collection. Defaulting by DEs could, in principle, be dealt with by resorting to provincial economic courts but since the BHH Company was made a national company under MARD such a move could be blocked by the provinces which control the courts. The situation changed in 1999, after riots erupted in Thai Binh in response to taxation perceived as abusive. DEs do not have to present balanced budgets anymore; following decentralization, the provinces became fully responsible for all financial matters relating to the DEs, and the payment of drainage pumping services in 'abnormal' years was devolved to them, rather than being handled by the MARD/central government. With the reduction in central funding and continuing need for capital maintenance and covering community drainage liabilities – the provinces ended up with bigger commitments to subsidy than they had before, driven by central policy but with the responsibility devolved.

Synthesis

The organizational and financial framework of water control in the Red River delta presents a complex and confusing image. While most countries in Asia have decided to provide irrigation service under high levels of operational subsidy, the Government of Vietnam attempted to recover a significant proportion of operating costs from farmers both before and after economic liberalization in the 1990s. Because of the relatively high cost of service provision arising from extensive pumping for both irrigation and drainage, pressure to recover costs intensified as the rest of the economy liberalized, squeezing the DEs between their service providers (electricity) and an already highly taxed farming population. On the one hand, the liberalization of the economy meant that production costs would have to be covered by the producers themselves and, on the other, the struggle for national food security after more than 30 years of war and scarcity, restrained the state from levying the full cost of hydraulic operations from farmers alone. Drainage service benefits the non-agricultural rural and urban population too; the public-good nature of this service justifies that the state covers part of the expenditures of the IDMCs and DEs and that the farmers and the state (central and provincial) shoulder cost recovery for irrigation and drainage. The Vietnamese State has tried to combine two political goals by striking a balance between rural stability and a service-cost approach to irrigation and drainage.

With the decentralization policy of the 1990s, the organization of the water control in the Red River delta became more complex. From a management point of view, some legislative capacity was transferred to the provincial level. From a technical point of view, the increasing involvement of cooperatives in irrigation and in the development of local pumping stations led to the effective redistribution of responsibilities between the IDMCs, DEs and the cooperatives. The resulting multiplication of circulars and rules for regulation at the central, provincial and communal levels created some heterogeneity and inequity in farm taxation. The water fees paid by farmers may be different from one cooperative to another. The calculation of income and expenditures of the DEs and IDMCs varies according to the province but this heterogeneity stems more from local political decisions than from the variety of hydraulic conditions.

The study also showed the benefits that can be drawn from decentralized and autonomous pumping stations, as opposed to centralized large-scale ones. Agriculture in the Red River delta grew dramatically in intensity and productivity thanks to the development of local pumping stations. The gains in flexibility and responsiveness to water needs came at the cost of what might appear to be excess pump capacity, but these gains are significant enough to encourage the development of local supply, even if the costs per hectare tend to be somewhat higher because of diseconomies of scale. The constraints of collective action are also better accepted by farmers within the limits of villages and communes, which are historically and culturally meaningful. Economically unsound development of local pumping stations may also be encouraged when farmers are able to access public funds and do not pay directly for the investments. The share of these investments paid by the communes varies with time and place.[19] Public funds can be sourced through the provincial budget, but this is an obscure point in which personal networks of influence[20] and the influence of the District Party Committees also play a great role.

Water pricing in the Red River delta is primarily geared towards ensuring partial financial stability. The closed nature of the Red River polders indicates that saving in pumping costs translates into financial gains but not into water savings at the macro level (in addition, contracts between cum and companies are generally made on the basis of area and not of volume). In any event, localized water shortages are due to inadequate management and insufficient hydraulic conveyance capacity of secondary canals in the face of uncoordinated pumping operations, rather than to a lack of water resources at the polder level. Even if water is not scarce and water savings largely irrelevant, decreasing abstraction would mean lower energy costs. While local stations have incentives to reduce their own costs, it must be noted that service by the cum is paid based on the area and is independent of the volume effectively supplied. Water charge mechanisms, therefore, have no direct impact on how much water is pumped and on the energy bill (Table 7.12).

The analysis of cooperative financial data suggests that farmers cover between 70% and 85% of O&M costs, not considering depreciation costs which remain dependent on state and/or provincial subsidies. This is, by world standards, a rather substantial contribution to cost recovery. In addition, the expression of the fee in terms of kilograms of paddy has successfully solved the common problem of erosion by inflation, by indexing costs to the price of food.

[19]Communes can use different local taxes or state subsidies to support such investments. In the late 1980s, for example, they used subsidies for agricultural input that were made redundant by the liberalization policy.

[20]Such networks may be linked to kinship, the village of origin, batches at the university or in the army, etc.

Table 7.12. Main actors and their strategies.

Actor	Constraints	Strategies	Observations
Farmers	No control on what the fees are for.	Develop local pumping capacity in order to facilitate intensification and diversification of agriculture. Get water when they need it, no matter what the cost is. Revolt if tax burden is unbearable.	Fees are area-based. Some village cooperatives introduced fees, based on actual costs: farmers pay for what they get and try to avoid unnecessary supplies.
Cooperatives	Need to cover their electricity and O&M costs. Direct pressure of farmers to get water on time. Need to earn income for other needs, services and activities at commune level.	Partly default on the fee to DE. Use fees for other purposes. Under-report the supplied area in contracts and negotiate water informally with central pumping stations. Get local pumping stations to be autonomous in irrigation management, and get access to more funds.	Investment in local pumps is expensive but their operation is cheaper than for centralized pumps.
Cums	Need to follow DE regulation. No means of controlling cooperatives' practices.	Satisfy the demand of cooperatives in order to complement their low official wages.	Do not have to justify pumping hours to the DE. Innovation: some cums sign contracts based on effective water consumed by cooperatives.
DEs	Have to ensure irrigation and drainage; do not control revenues; no flexibility for staff hiring. They are far from users and face cum staff's private strategy, opposed to DE's interest. The fees recovered do not balance their expenditures. Must cover the costs of drainage service in flood years and claim back subsidies – often paid one year late.	Adjust claimed service areas to almost match recovery. Defer maintenance. Wait for subsidies for big maintenance works. Take bank loans to cover operating expenses, particularly for electricity payment.	Have to justify pumping hours to the WRS. Do not have to present balanced budgets (since the abandonment of the 1997 reforms in 1999). Recovery at 92%.
Bac Hung Hai IDMC	Increasing indebtedness due to high operational costs, underpayment of bulk fees by DEs and failure by provinces to meet their financial obligations. Recovery only 72%. Occasional but irregular subsidies from the government.	Defer maintenance. Wait for government subsidies. Pass the debt on to a central state agency – in this case, the Ministry of Agriculture and Rural Development.	Do not have to present balanced budgets. Strategies to use the Economic Courts to enforce DE and other provincial payments have faltered.

Continued

Table 7.12. *Continued*

Actor	Constraints	Strategies	Observations
Province	Supposed to pay for the shortfall of revenue in case of a special year. Needs to provide subsidies to DEs since decentralization is in process (1999)	WRS/DE subsidizes third crop on centralized systems but not for cooperative pumping stations. Try to get subsidies from central government. Provide provincial directives to adjust national decrees to provincial conditions and policy.	Responsibility of each province lessened because four provinces are represented on the BHH IDMC board.
State	Has control over BHH IDMC through the Ministry of Agriculture and Rural Development and is requested by provinces to help for investments and major works. Has to adapt its policy to ecent changes which were not planned (emergence of local pumping stations) and decentralization to the provinces. The present institutional framework does not fit the present organization of irrigation. To get funds from international donors (which means to include some transfer measures in water policy); to reform without giving up strong administrative control of farmers.	Do not fully compensate for financial deficit as a way to maintain pressure on IDMC and to conserve its financial resources. Do not ask for full recovery in order to keep a balance between financial con straints and social peace.	Fear of countryside social unrest, as expressed in the Thai Binh riots of 1999.

Part of the fees is dedicated to the satisfaction of their irrigation needs but the opacity of the management of cooperatives does not allow farmers to estimate the adequacy of their payment with regard to the real costs incurred by cooperatives. This opacity is also allowed by the wide diversity of situations regarding water control (irrigation and drainage at field level may be achieved by gravity or with a complex mix of pumping operations) combined with an institutional diversity (the operations can be ensured by the cooperative and/or the company), which makes the calculation of fees very complex. Moreover, it also points to the fact that cooperative managers are generally administrative cadres, sometimes pursuing agendas beyond the scope of irrigation itself, as do company officials and district and provincial politicians. Local political practices are inclined to heavy investments in hydraulic equipment and in other infrastructures, such as roads, which can create an unbearable burden to the farmers: the 1999 riots in the Thai Binh province were motivated by mismanagement of the fees, which were raised and used for building roads and for paying bribes or extra salaries to the local authorities instead of for irrigation services.

One could argue that the water fees paid by farmers are still low in the Red River delta, but that the official water fees, which are often increased by many 'unofficial' subsidiary fees and taxes managed with little transparency, do not encourage farmers to contribute to the cost recovery of irrigation and drainage activities and generates mistrust. Water charges are not a goal in themselves, and are not something new in a context where farmers have paid taxes to the central state for centuries, but they should be linked to a clear definition of responsibilities and to management accountability. Interestingly, new contractual agreements signed between some cum and cooperatives aim to base payments on the cooperatives' effective water consumption, and tend to reinforce downward accountability.

The same opacity prevails regarding the management of IDMCs and DEs. The companies lack the incentives to present balanced budgets, since provincial or state subsidies will finally cover the deficit, and may be inclined to favour the satisfaction of their internal needs to the detriment of the quality of service. The permanent debt regarding the water diversion fee due to the IDMC and the electricity cost can be seen as a deliberate management policy: an *upward* transfer of the financial burden directly to the province, for the electricity, and to the state via BHH IDMC for the water diversion and main repairs.[21] This informal strategy was confirmed during interviews conducted with company officials during our research. At the same time, the companies also transfer part of their costs *downward* to the cooperatives by eliciting unofficial payments to field staff aimed at ensuring diligence and timely service. For the state, letting the debt grow might be a better strategy than purely making up for the financial shortfall with subsidies, since it allows maintaining a degree of pressure on provinces and districts by making manifest their lack of financial rigour (regardless of whether they are responsible for this or not). In addition, the state has now shifted some of its financial burden on to the provinces by making them responsible for covering possible extra costs in abnormal years.

All this shows that both within the cooperative level and between the cooperative and state companies, issues of water pricing are embedded within social networks based on kinship and political connections. Financial interdependence must therefore be seen not only as a mere contractual relationship, whereby financial flows are defined by reciprocal accountability and managerial rationality, but also as a part of the wider social and political web marked by shifting individual strategies, asymmetries of information and of bargaining power, and varying access to higher political strata. Just like in the case of cost recovery in the National Irrigation Administration of the Philippines, the model of contractual and financial autonomy of irrigation agencies proves to be oversimplistic in that it largely overlooks local politics (Oorthuizen, 2003).

Despite these qualifications, the crucial point is to determine whether the financial imbalance is the result of poor management and significant improvements are possible, or whether real constraints such as rising electricity bills, straightjacketing official regulation on fees and shrinking service areas do not allow companies to fare much better. Reality borrows from both ends, although our analysis tends to lean towards the latter. On the one hand, the overall financing of irrigation and drainage gives way to complex financial flows between nested levels of power and responsibility (farmers/cooperatives/companies and provinces/state), and the lack of transparency suggests that the economic efficiency of the service provision decreases due to financial losses at several levels. On the other, the debts of companies can be seen as implicit state subsidies made necessary by the political decision to keep water charges under a certain level. Since the overall taxation of households was shown to be quite high, this concern might be a practical recognition that surplus extraction by the state cannot be increased (the agricultural tax was reduced in 1993 in order to reduce the tax burden (Small, 1996), before being cancelled in 2001), and an indication that farmers' contributions might, after all, exceed what they get from the state in return, a point that

[21] At least for Bac Hung Hai and Bac Nam Ha polders.

needs further investigation. The apparent low percentage of companies' income spent on staff salaries (around 10%) indicates that administrative reforms might yield fewer gains than expected, although the extra payments made by farmers also show that these real costs might be higher than indicated.

In other words, the shortfall in the budgets of cooperatives, DEs and the BHH IDMC reflects both the non-optimal management of these organizations and the insufficient levies imposed on users, and the degree of defaulting that these organizations allow themselves is also a reflection of their perception of how much the state may be willing to pay, to avoid the transaction and political costs of engaging in more drastic or coercive reforms. It is also a measure of the 'distance' between the centre and decentralized administrative units, and of how upper bureaucratic layers fail to exert full control upon lower ones. From another point of view, it defines the trade-off between social considerations (constitutive of the Vietnamese Party's legitimacy) and macroeconomic constraints. Any institutional reform must question the distribution and share of responsibility in decision making, and introduce higher transparency in financing. This, of course, is an issue that cannot be restricted to the water sector and pertains to the wider question of political change in Vietnam.

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10 Wells and Canals in Jordan: Can Pricing Policies Regulate Irrigation Water Use?

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Introduction

The Hashemite Kingdom of Jordan is one of the countries with the scarcest water resources in the world. Due to both physical water scarcity and a high demographic growth during most of the second half of the 20th century it has been estimated that the per capita endowment of renewable blue water (i.e. surface runoff and groundwater recharge) is now only 163 m^3/year, while the average domestic consumption is 94 l/capita/day nationwide (THKJ, 2004).

Most agricultural activities are concentrated in the Lower Jordan River Basin (LJRB) (Fig.10.2), a region of prime importance for the country: it includes 83% of the total population, most of the main industries, and 80% of irrigated agriculture of the country. It is endowed with 80% of the country's water resources and withdrawals in the basin total 75% of those at the national level (Courcier *et al.*, 2005). The bulk of irrigated agriculture is located in two contrasting environments: the Jordan valley, where a public scheme supplies approximately 23,000 ha; and the highlands, which include two groundwater basins of major importance, the Amman-Zarqa and the Yarmouk basins[1] (Fig.10.2), where most of the private tube well-based irrigation that has developed over 14,000 ha in the last 30 years is located.

The main water allocation problems in the LJRB are schematized in Fig. 10.1. Amman receives water from the Jordan valley, local aquifers, and from southern outer basins. To meet its growing water demand, there is a need to: (i) improve inflow from the Yarmouk river (dam); (ii) transfer more water from the valley to Amman (and hence reduce agricultural use, although treated wastewater [TWW] is sent back to the valley); (iii) reduce abstraction from aquifers by highland agriculture in order to preserve water quality, avoid overdraft and reallocate water to cities; and (iv) rely on (costly) imports from southern basins as little as possible.

In the early 1990s, Jordan's officials took the measure of the coming water crisis and policies underwent a paradigm shift from supply augmentation towards demand management. The World Bank and other development agencies were influential in calling for an agenda that

[1]The Amman-Zarqa and Yarmouk groundwater basins are roughly coterminous with the river basins bearing the same names.

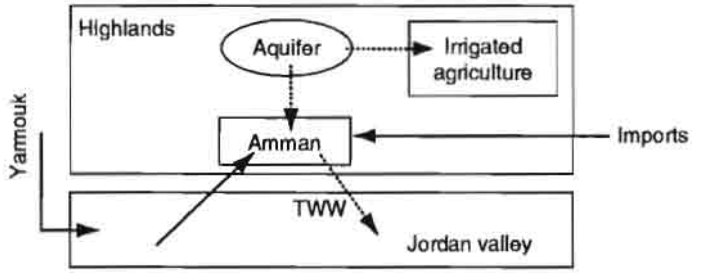

Fig. 10.1. Schematic representation of main water flows in the LJRB.

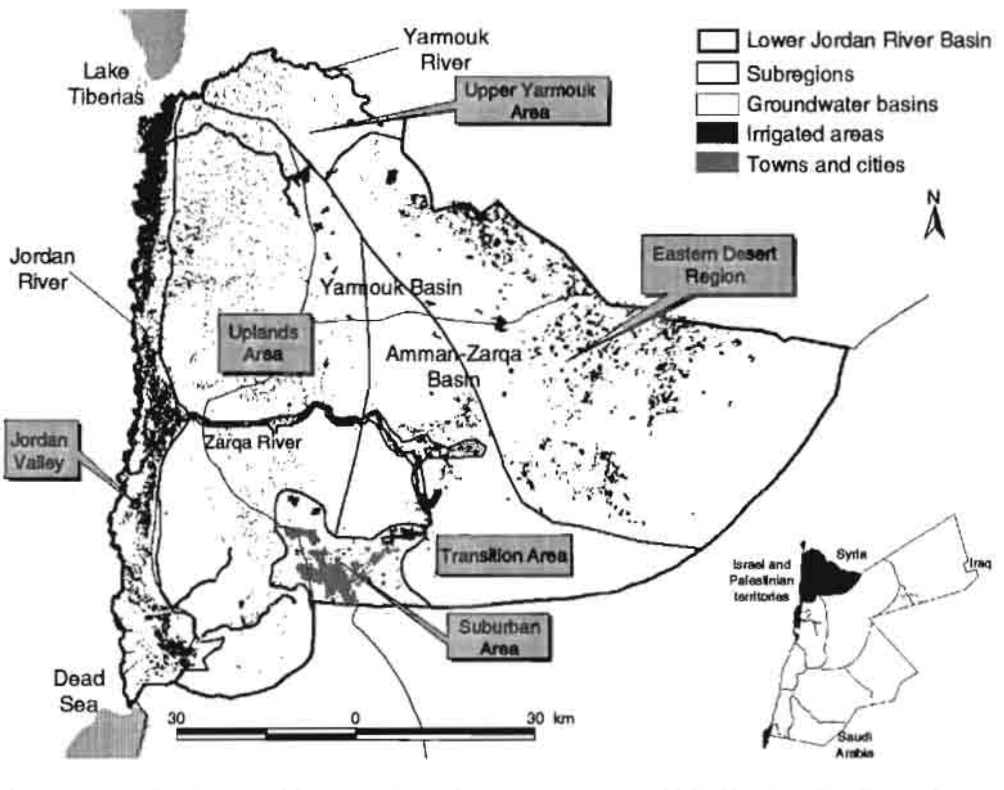

Fig. 10.2. Agricultural zoning of the LJRB (Adapted from Venot, 2004; unpublished land use classification from the Ministry of Water and Irrigation [MWI] and the Deutsche Gesellshaft für Technische Zusammenarbeit [GTZ].)

would include demand management measures and economic instruments to encourage efficient water use, transfer water to non-agricultural higher-value uses and reduce groundwater overdraft (Pitman, 2004). Pricing of irrigation water was chosen as an instrument to reduce demand for water (World Bank, 2003).

In the highlands, development of groundwater resources had been 'exacerbated by relaxed controls on drilling operations, and the near absence of controls on licensed abstraction rates' (THKJ and MWI, 1997b, 1998a). High rates of abstraction (up to 215% of the mean annual recharge in the Amman-Zarqa basin) prompted the government to design a new water strategy in 1997. Pricing policies were deemed to assist in controlling groundwater abstraction (with the ambitious task of taking abstraction rates 'close to the annual recharge by the year 2005'[2]) and to elicit shifts towards higher-value crops.

In the Jordan valley, more expensive water was expected to bring about efficiency improvements and a switch to less water-intensive crops, thus releasing water for Amman (World Bank, 2003). It would also assist in recovering state expenditures in public irrigation schemes: 'The water price shall at least cover the cost of operation and maintenance (O&M) and, subject to some other economic constraints, it should also recover part of the capital cost of the irrigation water projects. The ultimate objective shall be full cost recovery subject to economic, social and political constraints' (THKJ and MWI, 1997a, 1998b, 2004c; JRVIP, 2001a).

These reforms were to be embedded in the 1994 agriculture sector structural adjustment loan (ASAL) jointly funded by the World Bank and the German KfW and designed with the prime objective 'to support a transition to an optimal use of water and land resources' (ASAL, 1994; World Bank, 2003) and to tackle key problems of the sector: 'the lack of a national water policy, competing sector institutions, and insufficient attention to demand management'. Implementation of these policies proved to be problematic, since part of the government denounced the difficulties that increased agricultural water tariffs would cause and argued that administrative allocation together with efficiency improvement would be more efficient in saving water. Two hot debates arose.[3]

Regarding the highlands, the Groundwater Control By-law No. 85, passed in 2002 and further amended in 2004, was designed to regulate groundwater abstraction through the establishment of a block tariff system, with charging of water use over a threshold of 150,000 m^3/year/well. Regarding the valley, a block tariff system associated with crop-based quotas had been in place for some time and the debate revolved around possible increases in water charges. This chapter examines the rationale, the potential and the current impact of these water pricing policies in these two environments, and attempts to answer the following questions:

- What will be the likely impacts of the application of the by-law in the highlands?
- What will be the financial impact of increasing water prices in the valley, so as to cover O&M or capital costs?
- What is the likelihood of success of such policies in terms of water saving and raising economic efficiency, and what alternatives are available to meet these objectives?

In both the highlands and the valley, a typology of farming systems was established with the intent to discriminate the impact of policies on different types of farms and to assess what could be farmers' adjustments and responses in each case. Regional data aggregation then provided a wider picture of the water savings to be achieved, and of the financial impact on both farmers and the state. These results are developed in the final section, which discusses the disjuncture between expected and actual or estimated outcomes, points to commonalities and discrepancies between the two regions, and identifies measures which can improve the regulation of the water sector in Jordan.

Farming Systems in the Two Study Areas

Context

With the outflow of the Jordan river from Lake Tiberias virtually blocked by Israel, the lower Jordan river chiefly receives the water from its main tributary, the Yarmouk river. Several temporary streams of lesser importance named 'side-wadis', as well as the larger Zarqa

[2]This target was revised in 2004 and shifted to 2020 (Pitman, 2004).

[3]Opposition to higher water tariffs led to the occupation of the Parliament floor and further intervention by His Majesty the King (Pitman, 2004).

river, also incise the two mountainous banks and feed the valley: the valley is a 115 km long fertile plain located 300 m below sea level and where irrigation schemes have been built.

The highlands are composed of a mountain range running alongside the Jordan valley and of a desert plateau extending easterly to Syria and Iraq. While rain-fed cereals are grown near the mountains, precipitations become scarcer more to the east where only nomadic Bedouin livestock farming can be found, with a few localized plots of groundwater-based irrigated agriculture. The eastern desert region overlaps the Amman-Zarqa and the Yarmouk groundwater basins (cf. Fig. 10.2).

Irrigation is traditional in Jordan along the side-wadi valleys and on their alluvial fans spread in the Jordan valley itself, or wherever springs are available. Large-scale public irrigation dates back to the establishment of the Jordan Valley Authority (JVA) and to the construction, between 1958 and 1966, of the main 69 km long concrete canal – the King Abdullah Canal (KAC) – which parallels the river on its eastern bank. In 1962, a land reform led to the formation of thousands of small intensive farms (3.5 ha on average), and the settlement of numerous families, including Palestinian refugees (Khouri, 1981; van Aken, 2004). During the same period, several governmental projects aiming at settling Bedouins were implemented in the highlands and later gave way to a modern market-oriented agriculture developed by small to medium entrepreneurial farmers supplying growing cities and exporting their surplus around the Middle East (Elmusa, 1994; Nachbaur, 2004; Venot, 2004).

The heyday of irrigated agriculture was observed in the 1980s and early 1990s. In the Jordan valley, irrigation facilities were expanded and improved by the government, and modern irrigation and cropping techniques (greenhouses, drip irrigation, plastic mulch, fertilizer, new varieties, etc.), together with cheap labour from Egypt, became widely available. In the highlands, energy costs decreased and well-drilling techniques improved while land was cheap, fertile and not prone to diseases. During this period, agricultural revenues increased tenfold for vegetables and more than doubled for fruits: irrigated agriculture in Jordan enjoyed a boom in production and economic profitability that was described by Elmusa (1994) as the 'Super Green Revolution'.

With the growing competition from surrounding countries in the 1990s (Turkey, Lebanon and Syria) and the loss of the Gulf export market, the profitability of Jordanian agriculture decreased, strongly affecting farmers' revenue (Fitch, 2001; Jabarin, 2001) and taking the sector's contribution to the country's GDP down to 3.6%. Freshwater is increasingly transferred from irrigated agriculture (in the valley) to urban uses (in the highlands), affecting the agriculture sector which receives ever-decreasing quantities of water and becomes more vulnerable to droughts (Courcier *et al.*, 2005). In exchange, agriculture in the southern part of the valley is increasingly supplied with treated wastewater (McCornick *et al.*, 2001, 2002; THKJ *et al.*, 2002; JICA, 2004; THKJ and MWI, 2004b).

This chapter focuses on two main regions of the LJRB: (i) the eastern desert area (the only region of the LJRB highlands to be concerned by the by-law); and (ii) the northern and middle directorates of the Jordan valley (where JVA management rules apply). The total irrigated area in the eastern desert region totals 11,835 ha; 50% of this area is planted with olive trees, 34% with stone fruit trees (peach and nectarine trees essentially) and 16% with vegetables. In the northern and middle directorates of the Jordan valley, the irrigated area totals 19,345 ha, with 43% of vegetables, 42% of citrus, and the remainder of banana and cereals.

Farming system characterization

Farming systems were analysed in order to identify the different types of farms found in the valley and in the highlands. Understanding the socio-economic processes occurring at this microscale will allow us to better foresee the adjustments and the strategies developed by farmers in a changing context and the impact of water pricing policies on farmers. By complementing this microlevel analysis with regional data (statistic data, satellite image analysis) we can assess the possible evolution of regional irrigated agriculture as a whole.

Extensive farm surveys were carried out in the highlands by USAID/ARD in 2000/2001 (Fitch, 2001), but economic analyses were based on cropping patterns. This makes it difficult to discriminate responses by type of farmer. In order to sketch out farming systems that combine typical cropping patterns with socio-economic characterization (profile of the farmer, land tenure, labour use, costs, etc.), 30 in-depth farm surveys were carried out during the spring of 2003. Farming systems were then modelled in economic terms based on crop budgets whose consistency with USAID/ARD data was checked. Likewise, the main farming systems in the Jordan valley were identified and their economics modelled based on 50 farm surveys carried out also during the spring of 2003, and on other studies (ARD and USAID, 2001b; JRVIP, 2001c).

The highland surveys led to the identification of three main categories of farming systems (Table 10.1; a detailed description can be found in Venot *et al.*, 2007). They include settled Bedouins who have taken up vegetable (and sometimes fruit tree) cultivation, and urban-based entrepreneurs involved in high-value fruit production and closely managing their farm, although they often reside in Amman. Both Bedouins and entrepreneurs sometimes also maintain olive orchards in parallel. Other absentee owners adopt more extensive agricultural systems (with open-field vegetables or olive trees) and employ a manager. The main differences between these farming systems are the degree of capital use and intensification, and the direct/indirect type of management.

Generally speaking, farming systems in the Jordan valley are more intensive than in the highlands: farms are smaller (3.5 ha on average against 20–25 ha in the highlands) and net benefit per hectare (for similar crops and/or farming systems) is generally higher. The survey identified five main categories of farming systems (Table 10.2). They include family farmers who either own or rent the land and grow vegetables in open fields; entrepreneurial farmers who adopt capital- and labour-intensive techniques like greenhouses with a high return on investments; citrus orchards cultivated in the north of the Jordan valley and managed either by the family who owns the land, or by absentee investors interested in the social rather than the economic value of their farm; highly profitable bananas grown in the extreme north of the valley; and, finally, some poorer farmers with more extensive vegetable cultivation, associated with small orchards.

Control of Groundwater Overabstraction in the Highlands

The problem of groundwater overdraft

Since the 1930s, when the first wells were dug in the Azraq oasis, to the present, groundwater abstraction in the highlands has increased to meet the needs of agriculture, industries and cities, although the part of agriculture has decreased in both absolute and relative terms in the last decade. According to the official figures of the MWI for 2004, total groundwater abstraction in the LJRB reached 248 Mm^3, of which about half was used in agriculture (THKJ, 2004). In the highlands, in the Amman-Zarqa and Yarmouk groundwater basins, local groundwater abstraction reached 215% and 125% of the annual recharge, respectively. Taking return flows from municipal/industrial and irrigation uses into account, the overall net depletion of these aquifers comes down to 159% and 98% of their annual recharge, respectively.

The resulting drawdown of the aquifer is paralleled with a decline in water quality (due to increasing salinity and use of fertilizers and pesticides) and it is feared that both domestic and agricultural uses could be jeopardized, and further costly investments in water treatment needed (ARD and USAID, 2001a; JICA, 2004). In addition to these salinity problems, aquifer overdraft incurs growing pumping costs to all users and the abandoning of some wells (Chebaane *et al.*, 2004).

Groundwater policies and by-law No. 85 of 2002

Faced with such problems the Government of Jordan has tried to reorient its water policy through the Water Strategy Policy of 1997.

Table 10.1. Profile of main farming systems (highlands, eastern desert region).

	Settled Bedouins			Stone fruit tree entrepreneurs		Absentee owners	
	Family vegetable farm	Mixed farm vegetables and olive trees	Family fruit tree farms	Intensive entrepreneurial farmer	Intensive absentee owner – stone fruit trees and olive trees	Prestige olive tree farm	Extensive open-field vegetables
Land tenure/ water access	Rent	Ownership	Ownership	Ownership	Ownership	Ownership	Ownership/ Rent
Farm area range (ha)	20–25	(20–25+10–15)	10–20	25–35	40–80	15–35	20–25
Net benefit (US$/ha/yr)	1,100	621	6,900	16,000	14,850	300	600
Net benefit (US$/farm/year)	24,750	21,750	103,500	480,000	891,000	7,500	13,500
Number of wells	1	1	1	1	2	1	1

Table 10.2. Profile of main farming systems (Jordan valley, northern and middle directorates).

Farming systems	Open-field vegetable family farms	Entrepreneurial greenhouse farms	Citrus farms: Family farms	Citrus farms: Absentee owners' farms	Banana farms: Family farms	Banana farms: Entrepreneurial farms	Poor farmers: Mixed farms
Land tenure	Rent/ Ownership	Rent/ Ownership	Ownership	Ownership	Ownership	Ownership/ Rent	Rent/ Sharecropping
Farm area range (ha)	3–6	6–10	3–6	1–20	1–5	1–5	1–3
Number of family workers	2–5	1–2	3–5	1	3–5	1–2	4–10
Net benefit (US$/ha/year)	3,800	7,500	1,250	400	7,000	12,500	1,050
Net benefit (US$/farm/year)	17,100	60,000	5,625	4,000	21,000	37,500	2,100

Table 10.3. Water prices according to the volume abstracted in private agricultural wells. (From THKJ and MWI, 2002b, 2004a as mentioned in by-law No. 85 of 2002.)

Quantity of water pumped	Water prices in wells with former abstraction license – 2002 by-law	Water prices in wells with former abstraction license – 2004 amendment	Water prices in wells without former abstraction license
0 to 100,000 m³	Free	Free	JD0.025/m³ ($0.035)
101,000 to 150,000 m³	Free	Free	JD0.030/m³ ($0.042)
151,000 to 200,000 m³	JD0.025/m³ ($0.035)	JD0.005/m³ ($0.007)	JD0.035/m³ ($0.050)
More than 200,000 m³	JD0.060 /m³ ($0.085)	JD0.060/m³ ($0.085)	JD0.070/m³ ($0.098)

Several measures have been taken to decrease groundwater abstraction, including: (i) freezing of well-drilling authorizations in 1992; (ii) implementation of a tax of $0.35/m³ for any water pumped and sold/used for industrial or aesthetic purposes (since 1994) as well as for domestic purposes (since 2002); (iii) a campaign to equip private wells with water meters; (iv) reduction of losses in urban networks; (v) promotion of less water-intensive/high-value crops; and finally (vi) promulgation of the groundwater by-law No. 85 of 2002 (Chebaane *et al.*, 2004). Government policies called for a massive reduction in abstractions by highland pumpers by 86 Mm³/year until 2010, and by a further 36 Mm³/year until 2020 (World Bank, 2001b). Water savings elicited by the new water charges were expected to reach about 40–50 Mm³ over the next 3–5 years (Checchi and Devtech, 2003).

From 1962 to 1992[4] licenses to drill agricultural wells were granted by the government. Two-thirds of the licenses granted specified the maximum amount of water that each farmer could pump (most commonly 50,000 or 75,000 m³/year, and sometimes 100,000 m³/year after 1990; Fitch, 2001) but these limits were never enforced (THKJ and MWI, 1997b, 1998a). In 2002, the groundwater by-law introduced a system of quotas combined with taxation of any use exceeding the quota. However, instead of endorsing previous license quotas, the by-law allowed uncontrolled abstraction up to a limit of 150,000 m³/year/well, a volume much larger than the limits mentioned in the licences. Rules for the taxation of the water pumped above this limit are detailed in Table 10.3.

It has been reported that farmer interest groups have got the authorities to cancel the former licenses against the acceptance of the principle of taxing volumes abstracted above a certain limit (Pitman, 2004): technical, institutional and political difficulties act as impediments to the effective implementation of the reforms.

In April 2004, the first bills, corresponding to water consumption between 1 April 2003 and 31 March 2004, were sent to farmers. Until November 2005, no employee of the MWI had been entrusted with the task of collecting fees. In these conditions farmers have not yet paid these bills.

Between May and August 2004, two amendments have modified the regulation: the first one is a lowering of the already low fees for the volumes abstracted in licensed wells between 150,000 and 200,000 m³/year. Volumes will be charged at Jordanian dinar (JD) 0.005/m³ instead of JD0.025/m³ (cf. Table 10.3). The second amendment concerns abstraction from brackish aquifers: the higher the water salinity, the lower the fee; it will have an impact in the south of the Jordan valley and in the Azraq basin (east of the country) but not in the LJRB highlands.

Implementing the by-law is now possible since most of the wells are equipped with water meters (94% according to Al-Hadidi, 2002). However, several problems must be underlined. First of all, in 2001 only 61% of the meters were functioning properly (Fitch, 2001) and, although major replacement campaigns have been conducted, this problem is likely to recur.

[4]No drilling license has been delivered after 1992. However, the number of operating wells is continuously increasing as illustrated by the records of the Water Authority of Jordan for 2004. This may be due to the development of well metering.

Moreover, there is an important lack of material and human resources since controls are handled by only a few employees of the Water Authority of Jordan (WAJ). Another problem arises because meters are still not protected. Experience in the Jordan valley has shown that if water meters are not protected in a box closed with a padlock, they are likely to be broken or at least fiddled with (Courcier and Guérin, 2004). In the highlands, the risks of deterioration are reduced because the meter is paid for by the farmer but, on the other hand, tampering is quite easy and could become common.[5]

Financial impacts and expected adjustments in eastern desert's farming systems

Based on the description of farming systems presented earlier, this section explores the financial impact of the by-law on each type of farming system and how this impact could be mitigated by possible farmers' strategies.

Financial impacts of the by-law on farming systems

Table 10.4 summarizes financial impacts (before and after the 2004 amendment, Scenario A and Scenario B, respectively) on farms with licensed wells, assuming that actual withdrawals remain unchanged.[6]

Settled Bedouins with fruit tree farms and absentee owners with prestige olive trees will not be affected by the by-law since their current annual water consumption is less than 150,000 m³/well. Fruit tree farmers will be very slightly affected by the by-law. Table 10.4 illustrates that the amendment considerably softened the financial impact of the by-law on settled Bedouins with vegetables or mixed farms and absentee owners with vegetables.[7]

To assess possible farmers' responses it is necessary to know what the present irrigation efficiency in the eastern desert is and to what extent the quantity of water supplied to crops matches their water requirements. Surveys have shown that orchards (especially olive trees)[8] are underirrigated with regard to full agronomic requirements: further water savings are thus unlikely. On the other hand, vegetable farmers abstract nearly 160% of the net crop water requirements, as evaluated by Fitch (2001). In this condition, the overall efficiency of water use in vegetable farms only reaches 62% and can be improved without affecting production. If we assume that on-farm irrigation efficiency can reach a maximum of 75%, vegetable farmers could decrease the amount they pump from 216,000 m³ down to 179,760 m³ while still meeting net crop water requirements.

The financial impacts at the farm level of four different scenarios are presented below: (A) the first scenario assumes a maximization of water savings by a decrease of water use down to 150,000 m³/well/year (so that no fee needs to be paid), and a proportional reduction in the cultivated area (water use efficiency remains constant); (B) the second scenario assumes that farmers pay their water bills without changing their water consumption; (C) in the third scenario farmers increase irrigation efficiency up to 75% (still meeting crop water requirements) and reduce water abstraction; and (D) the fourth scenario is like Scenario C, but farmers do not reduce abstraction and use

[5]Anecdotal observations during our surveys showed that tampering and 'compromising' with WAJ employees did exist.

[6]Unlicensed wells in Jordan are mainly located near the Azraq oasis (east of the LJRB) and in the south of the Jordan Valley where they tap the brackish aquifer. For the sake of simplification, the following quantification assumes that all wells in the highlands of the LJRB have a license.

[7]For mixed farms, we have presented a case where farmers have only one well. In these conditions, impacts of the by-law are expected to be high. However, many of these farmers have two separate wells that they use indifferently to irrigate two different plots. In the latter situation, the by-law will not have any impact on them and no changes are expected to occur.

[8]Only 56% of olive-orchard requirements are met: this very low satisfaction (also observed by Hanson, 2000) illustrates their drought-tolerance quality and also their very low profitability. Deficit irrigation highlights that these orchards have a high social value but that their conventional economic profitability is not of prime importance to farmers. Farmer strategies do not boil down here to profit maximization.

Table 10.4. By-law impact on farm income in the eastern desert.

		Settled Bedouins			Stone fruit tree entrepreneurs		Absentee owners	
		Family vegetable farm	Mixed farm vegetables and olive trees	Family fruit tree farms	Intensive entrepreneurial farmer	Intensive absentee owner – stone fruit trees and olive trees	Prestige olive tree farm	Extensive open-field vegetables
Net benefit (US$/ha)		1,100	621	6,900	16,000	14,850	300	600
Water use (m^3/farm/year)		216,000	284,750	150,000	300,000	435,000	137,500	216,000
Actual abstraction costs	US$/ha	2,181	1513	1,373	1,310	1,310	432	1,875
	US$/farm	49,072	52,955	20,595	39,300	78,600	10,800	42,187
	% of current revenue	198	243	19.3	8.2	8.8	144	312
A – Extra water costs by-law	US$/ha	138	259	–	342	108	–	138
	US$/farm	3,110	9,050	–	10,250	6,475	–	3,110
B – Extra water costs by-law and amendment	US$/ha	76	217	–	295	61	–	76
	US$/farm	1,710	7,621	–	8,850	3,675	–	1,710
Revenue decrease (% of current revenue)	Scenario A	12.6	41.6	–	2.1	0.7	–	23.0
	Scenario B	6.9	35	–	1.8	0.4	–	12.7

Table 10.5. Financial impacts of the by-law (with amendment) on settled Bedouins farms and absentee owner vegetable farms according to the four response scenarios.

		Settled Bedouins		Absentee owner
Farming system category		Open-field vegetable family farm	Mixed farm vegetables and olive trees	Open-field farm
Scenario A	Volume abstracted (m³/well)	150,000	150,000	150,000
	Change in revenue – US$/ha and % of current revenue	– 341 (–31%)	– 264 (–43%)	– 186 (–31%)
Scenario B	Volume abstracted (m³/well)	216,000	284,750	216,000
	Change in revenue – US$/ha and % of current revenue	– 76 (–6.9%)	– 217 (–35%)	– 76 (–12.7%)
Scenario C	Volume abstracted (m³/well)	179,760	218,760	179,760
	Change in revenue – US$/ha and % of current revenue	– 379 (–34%)	– 426 (–68%)	– 379 (–63%)
Scenario D	Volume abstracted (m³/well)	216,000	284,750	216,000
	Change in revenue – US$/ha and % of current revenue	+ 129 (+12%)	+ 35 (+5%)	+ 46 (+8%)

the water saved to increase the cultivated area. We hypothesize that irrigation efficiency can be improved up to a maximum of 75% through a better design of the farm network, the use of higher-quality emitters, better on-farm operations, and a better monitoring of soil water reserves that would allow fine-tuning of irrigation, thanks to the involvement of more specialized technicians. The cost of such changes can be estimated at about $370/ha/year (Courcier, 2006, personal communication [by e-mail 20 May 2006]).[9] Contrary to common assumptions that farmers can easily save substantial amounts of water by just being 'more careful', improvements demand better knowledge and material and thus have a cost, especially in a situation where microirrigation is already in use. Assessing such costs is a difficult task, and the willingness/ability of farmers to achieve these improvements will depend on these costs.

Adjustments to be observed in open-field vegetable and mixed farms

Table 10.5 summarizes the impacts of the four scenarios on extensive vegetable farms run by settled Bedouins or absentee owners.

[9]This cost can be broken down into: $90/ha/year of incremental wage and $280/ha/year for dripper lines as well as for primary and secondary pipes, filters and tensiometers. To increase efficiency above 75%, there is an additional need for skilled engineers as well as for computerized systems that would cost about $1400/ha/year, with an initial investment of $1100/farm (Courcier, 2006, personal communication [by e-mail 20 May 2006]). The incremental cost to increase efficiency up to 75% is lower than the extra revenue that the farmer would derive from expanding his field and using saved water, but other constraints can explain why a 'farmer-maximizer' has not yet increased his irrigation system efficiency. These include aversion to risk or to incremental labour and time to be spent on the farm, as well as a low investment capacity, especially in a situation where most Bedouin farmers are indebted (Cheebane et *al.*, 2004). The relative high costs (compared to farmers' revenue) of increasing efficiency above 75% make such an evolution unlikely.

For settled Bedouins with vegetables in open fields, reducing the land area until water abstraction is curtailed down to 150,000 m^3/well/year (Scenario A) entails a decrease in income of 31%. Paying the water fee (B) is a much better strategy (–6.9%), even though farmers already face water costs which are higher than their net income (cf. Table 10.4). Improving efficiency without increasing cropping area (C) entails a 34% decrease in farm revenue. If actual costs of improving efficiency are lower than $76/ha, (a rather low value compared with our estimate of $370/ha), then strategy C is cost-effective. Strategy D seems a better option with a 12% increase in farm revenue, due to the expansion of the irrigated area. Conclusions for absentee owners are similar: Scenario D is the best option but another possible strategy for well owners would be to rent out their wells to large entrepreneurial fruit tree farmers or to cities (cf. below). It is noteworthy that these conclusions would not have been significantly different with the pre-amendment price of water.

These results confirm the fact that technology costs are in general much higher than corresponding savings in the water bill, unless prices are taken at very high levels. In other words, even in the present case where water costs are very high, saving water is rarely cost-effective for farmers, and price incentives alone are unlikely to reverse this situation. However, in regions with abundant land, savings derived from improved irrigation efficiency can be used to expand the cropping area in a cost-effective way (Scenario D). Since, under conditions of high water costs, higher water costs deplete incomes, they may also trigger adoption of higher-value crops.

To avoid paying any water fee (A), settled Bedouins with mixed farms would have to decrease their current abstraction of 284,750 m^3/year by 47%, incurring a drop in income of 43% (the farmer would first abandon his olive orchard and then shrink its [more profitable] vegetable area). The average income is so low that paying the fees (B) would entail a 35% decrease in revenue (pre-amendment water prices would have sent a stronger signal but at the cost of more than half the current income). Strategy C would be even worse with an expected decrease in revenue of about 68%. Finally, as in the case of vegetables, improving efficiency and increasing the cropping area (D) would offset the financial loss due to the by-law and increase farmers' revenue by 5%.

Adjustments to be observed in entrepreneurial fruit tree farms

Intensive stone fruit tree entrepreneurs will be slightly affected by the by-law. In line with their large water abstraction, farmers will have to pay high water fees (between $3675 and $8850/farm according to the farming system; cf. Table 10.4). However, due to the high profitability of these farming systems, this increase in water prices will have a negligible impact on farmers' revenue (~2%).

In all likelihood, Scenario B will prevail, that is, farmers will squarely foot the bill. In systems where trees are underirrigated and efficiency already high, Scenarios C and D are very unlikely. Scenario A, however, might also be an option if there is a possibility for farmers to rent an additional nearby well: this new well would provide both the shortfall of water needed for the old orchard and additional water for expansion. The availability of large flat desert areas would make this option quite easy (although it is illegal because areas attached to a particular well are normally specified) and economic calculations show that such an expansion would be profitable, even with the cost of well renting (about $18,000/well). This rent is also higher than the total revenue generated at present by extensive open-field farms managed by absentee owners and would also make this option attractive to them. This could accentuate the current increase in stone fruit production by entrepreneurial farmers in the highlands. In such a case, there will not be any water savings but higher productivity will be achieved through the shift from vegetables to fruit trees.

Water savings at a regional scale

A land-use mapping carried out by the MWI and the GTZ based on two mosaics of

LandSat images dated August 1999 and May 2000 was used to estimate irrigated areas within the Amman-Zarqa and Yarmouk groundwater basins, giving a total of 14,460 ha with a breakdown between olive trees, fruit trees and vegetables. Based on these estimates of irrigated areas and on crop water use data, we can approximate groundwater abstraction in the Amman-Zarqa and the Yarmouk basins and compare these values with earlier estimates from other sources, and with annual recharge values given by THKJ (2004).

Results show that gross agricultural abstraction records of the MWI are 20% below other evaluations. The MWI may underestimate present agricultural abstraction, partly due to the difficulties attached to water metering mentioned above. In our estimate, gross abstraction rates are presently reaching 249% and 195% of the annual recharge in the Amman-Zarqa and Yarmouk basins (or 179% and 168% if return flows of irrigation and municipal/industrial uses are considered, i.e. net abstractions of 121 and 63 Mm^3/year). These estimates will be used as a baseline situation in the following sections to assess possible water savings in the two groundwater basins considered.

Information on the different classes of agricultural wells according to their yearly production in the two groundwater basins of Amman-Zarqa and Yarmouk shows that out of the 606 wells located in these two basins, only 182 yield more than 150,000 m^3/year and will thus be concerned by the by-law (MWI records for 2004). Discounting government wells producing more than 500,000 m^3/year, this figure drops down to 166 wells that represent 38% of water abstracted in these two basins. Finally, as shown above, since only settled Bedouins with vegetables or mixed farms and absentee owners with vegetables are likely to respond to the by-law, only 83 wells in the eastern desert (90% of these in the Amman-Zarqa basin) will eventually be affected by the by-law.

Regional water savings can be assessed based on the four scenarios considered earlier by aggregating responses expected for each type of farm. Table 10.6 shows that the maximum gross water savings to be expected in vegetable plots in the eastern deserts are about 5.5 Mm^3/year (90% of these in the Amman-Zarqa basin). These savings would be obtained if all vegetable farmers decreased their water application and irrigated area by one-third on average, while maintaining their actual water use efficiency (Scenario A). This would lead to high agricultural losses ($2.5 million, not shown). This response, however, is not the one that the incentives in place are likely to prompt.

In Scenario B, nothing is changed except for a transfer of $0.21 million from vegetable farmers to the state coffers, or a total of $0.84 million if payments of all farms are considered. Improving efficiency without increasing cropping area (Scenario C) would reduce abstracted volumes to around 179,760 m^3/well/year in vegetable farms. In such conditions, gross water savings would reach 3.0 Mm^3/year and the regional gross overdraft would be decreased by about 2.2%. The net abstraction would not be affected by this change.

Finally, Scenario D would lead to increasing the depleted fraction by about 2.3 Mm^3/year (as cropping area and efficiency increase, and return flows are reduced), which would defeat the objective of the by-law. Generally speaking, encouraging higher efficiency in conditions where land is not a constraint is counterproductive to the objective of reducing the depletion of water resources. The fact, however, that expanding cultivation by using saved water is – on paper – financially profitable but not observed strongly suggests that the real costs of increasing efficiency may be higher than what has been considered here.

In conclusion, we can say that the implementation of the by-law in its current form will not lead to significant water savings. Because of the threshold of 150,000 m^3 and the weight of the public wells, 72% of the wells in the Amman-Zarqa and Yarmouk basins will not be affected by the by-law (a threshold of 100,000 m^3 would take this proportion down to 53%). Olive orchards, for example, which represent 32% of the total agricultural water abstraction in the highlands and qualify as the

Table 10.6. Impact of the by-law on vegetable farms at the basin level (eastern desert zone).[a]

	Abstraction (m^3 per year and per well)	Gross water savings (Mm^3/year)		Net water savings (Mm^3/year)		Depleted fraction in vegetables (Mm^3/year)	Government revenue from vegetable farms (Million US$)	Overall government revenue (Million US$)
		Mm^3/year	% of current gross overdraft	Mm^3/year	% of current net overdraft			
Present situation	216,000	–	–	–	–	11.1	–	–
Scenario A: maximizing water savings	150,000	5.5	4.0	3.4	4.2	7.7	–	–
Scenario B: payment of water fees	216,000	–	–	–	–	11.1	0.21	0.84
Scenario C: improving efficiency area constant	179,760	3.0	2.2	–	–	11.1	0.012	0.63
Scenario D: improving efficiency increased area	216,000	–	–	–2.3	–2.9	13.4	0.21	0.84

[a]For Scenarios C and D, all calculations have been done considering an achievable irrigation efficiency of 75% (in vegetable farms). For Scenarios A and B we considered the present efficiency in vegetable farms (62%). System efficiencies in olive and other orchards have been considered homogeneous at 70% and 80%, respectively, in the four scenarios.

prime target of policies because of their low water productivity (WP) (WP = \$0.05/m^3) will not be affected. If we add to this the facts that high-value crops such as fruit trees (WP = \$1.1/m^3) will be financially little affected and that farmers' behaviour is unlikely to change, then the 83 wells concerned correspond to only 18% of the total water abstraction (16.1 and 1.8 Mm^3/year in the Amman-Zarqa and Yarmouk basins, respectively).

Vegetable and mixed farms are most vulnerable to hikes in water charges: this is because their income is so low that any additional production cost will depress them further. However, it is unlikely that such pressure would result in significant water savings, since improving efficiency would require investment in technology and qualified labour that are: (i) higher than gains resulting from a reduced water bill; and (ii) beyond the capacity of most of these farmers, many of whom are indebted.

Upper (optimistic) estimates of reduction in gross water abstraction (Scenario A for vegetable and mixed farms) point to a decrease by 4%, that is, 5.5 Mm^3/year, a drop in an ocean of overabstraction, and quite short of the 40–50 Mm^3 hoped for.[10] Revenue to the government is expected to vary between \$0.63 and \$0.84 million/year, not considering the costs of collection and enforcement.

With higher charges (like in the pre-amendment price table, for example), olive orchards and fruit tree farms would remain insulated but the pressure would be made to bear on the most vulnerable vegetable and mixed farms; with a lower threshold, olive orchards would be under pressure too. In all likelihood, few of these farms would be in a position to invest in order to achieve better efficiency (nor would economies in the water bill ever offset the costs of doing so). Affected farmers might just decrease their area and water abstraction (incurring a loss in their income) until they reach the threshold and avoid water charges.

But they might as well sell their water to neighbouring fruit farmers, rent out their wells (if they own them) and move out of agriculture. This would amount to a shift in production from vegetable farming and olive trees to higher-value fruit production, and would definitely raise the productivity of water, but: (i) benefits would accrue to wealthier entrepreneurs; (ii) this would defeat earlier social policies aimed at settling Bedouins by providing them opportunities in the agriculture sector (Chebaane *et al.*, 2004), unless they are able to find equivalent or better job opportunities; (iii) the amount of water used would not be radically altered; and (iv) water demand would become extremely inelastic because of the high crop return; worse, the shift to higher efficiency fruit (or other) production could have the perverse consequence of allowing expansion of orchards, with lower return flow to the aquifer, greater depletion of water, and thus worsening of the status of the aquifer.

Because of the large share of unaffected farmers and likely impacts in terms of crop shifts rather than of improvements in efficiency, a substantial drop in water abstraction can only be obtained through the diminution of either the cultivated area or the number of wells in use. As demonstrated above, negative incentives (reduced thresholds, higher tariffs, petrol taxation, stricter enforcement, etc.) cannot achieve this without displacing weaker farmers and strictly prohibiting the selling/renting out of wells, but recent political crises suggest that such extreme measures are unlikely to be accepted. Attendant positive incentives, such as buying-out of wells (a measure envisaged by the government and considered positively by 50% of farmers [Chebaane *et al.*, 2004]), compensation for the uprooting of olive trees in the eastern desert (Fitch, 2001) and substituting treated wastewater for groundwater (ARD and USAID, 2001b) are more promising. Additional measures include reduction of losses in urban networks, educational and public awareness programmes for water users, allowing transfer of water to neighbouring orchards and the possibility of renting out wells (which would offer financial compensation but would not contribute to conservation objectives [Chebaane *et al.*, 2004]). Last, the removal of petrol subsidies for well operation or higher taxation of water must be accompanied by measures that provide

[10] If abstraction of all private wells was to be reduced to 150,000 m^3/year, total gross water savings would reach 12.5 Mm^3/year.

alternatives to people moving out of low-value agriculture, such as subsidies or secure market opportunities to help viable farms to intensify production.

Water Pricing in The Jordan Valley

Water allocation

From the beginning of large-scale irrigation in the Jordan valley, in the 1960s, a crop-based system of water allocation by quota has been used to supply water to irrigated schemes. Volumetric pricing was also initiated in 1961, with a cost of fils1/m^3 (Hussein, 2002; one fils is equivalent to JD0.001 or $0.0014). The official quota system has undergone several changes since the 1960s and has been mainly used as a guideline, with adaptations according to circumstances and national priorities (THKJ and JVA, 1988, 2001). According to quotas defined in 1988 (THKJ and JVA, 1988), each plot of vegetable grown between mid-April and mid-December received 2mm of water/day (during the rest of the year water was allocated on demand). Citrus and bananas were supplied with 4 and 8mm/day, respectively, from the beginning of May to the end of October (and on demand during the rest of the year, when demand is low). Historical large landowners (mainly citrus owners) as well as entrepreneurial farmers growing bananas are the main beneficiaries of these quotas.

Bananas and citrus are highly water-consuming crops and were traditionally cultivated in the northern part of the Jordan valley (Khouri, 1981; Elmusa, 1994): their higher quotas have now been frozen resulting in the institutionalization of some inequity in the access to water in the Jordan valley. Only the plots planted with bananas before 1991 are eligible to a 'banana allotment'. In 2004, however, in contradiction to its policy to reduce demand, the JVA legalized citrus orchards planted between 1991 and 2001, granting them the citrus allotment instead of the vegetable allotment they were receiving before. All other areas receive the vegetable allotment if the farmer declares to the JVA that he is cultivating his plot.

The 1997–1999 period was marked by a severe drought which, in 1999, made ad hoc reductions in farm allotments necessary. While some areas had to be left fallow, it is not clear whether impacts on yields were observed, but these reduced quotas have been maintained ever since (except in the south of the valley, where treated wastewater is used). In 1999, vegetables and citrus were allocated 75% of their allocation while bananas received 85% of their quotas. Allocations were reduced by 25% in 2000 and 2003, and by 50% and 40% during the summer 2001 and 2002, respectively.

In 2004, the JVA proposed new quotas expected to better match supply and crop water requirements (THKJ and JVA, 2004). These recommendations are close to the reduced quotas of 1999. On a regional scale, changing from the previous allocation system (2, 4, 8mm/day) to the new recommended values yielded total water savings in the northern and middle directorates (where the rules apply) of about 20.2Mm^3/year (between April and November), which were reallocated to domestic use in Amman.

O&M costs recovery

Revenues from irrigation water have gradually increased with time, as water charges established at fils1/m^3 in 1961 later increased to fils3/m^3, then to fils6/m^3 in 1989, and to an average of fils15/m^3 in 1996 (GTZ, 1993; FORWARD, 1998; the planned increase up to fils25/m^3 has been delayed).

Revenues from charges covered one sixth of O&M costs during the 1988–1992 period (GTZ, 1993; Hussein, 2002), which meant a corresponding average annual subsidy of $3.4 million. In 1995, less than a quarter of O&M costs was recovered. Charges were then increased more than twofold and data for 1997 point to a rate of recovery of O&M costs of two-thirds, with an average charge of fils15/m^3 (against fils18/m^3 of O&M costs) and a rate of defaulting of 20% reducing actual revenues down to fils12/m^3 (FORWARD, 1998; World Bank, 2001b).

Calculations for 1988–1992 showed that fixed asset depreciation and financing costs were twice higher than O&M costs proper (total costs were thus three times higher than O&M costs) (GTZ, 1993). THJK (2004) indicated that the ratio of average

Table 10.7. Crop-based water costs according to three different levels of price increase.

Cost of water ($/ha/year)	Vegetables	Citrus	Bananas
Current water costs	67	138	350
A. O&M costs recovery-block tariff system	94	191	485
B. Total costs recovery (O&M + capital costs)	278	573	1454
C. 80% of water costs borne by farmers in the highlands	586	1172	1740

capital costs to O&M costs was 2.07 for the 1997–2002 period.

Based on the actual block tariff system (FORWARD, 2000; cf. Appendix) we have estimated average costs per m^3 and per year for each type of crop according to the recent JVA recommendations (see details in Venot *et al.*, 2007). Total water costs for the farmers are higher in banana plantations ($350/ha/year) than in citrus orchards ($138/ha/year). They are lowest in vegetable farms which consume less water ($67/ha/year). Differences in water charges for each crop are lower than previously, since uses have been capped. The main beneficiaries of this evolution are banana farmers whose consumption rarely reaches expensive tariff blocks. The new JVA recommendations lead to lower water use and consequently to a lower overall level of O&M cost recovery, with an average charge of about fils13/m^3.[11]

In line with these recent evolutions, despite substantial differences between sources, we will consider here that current charges cover 72% of O&M costs and that full costs are three times higher than O&M costs.[12]

Economic impacts and adjustments at the farm level

This section provides financial evaluations of a rise in water prices according to three different scenarios. First, we will consider that water prices will increase up to a level where O&M costs of the JVA are recovered; this is the main objective of water pricing policies in Jordan (FORWARD, 1998; THKJ and MWI, 1998c, 2002a; Salman, 2001; THKJ *et al.*, 2002; THKJ, 2004). Second, we will consider a water price increase allowing the recovery of total costs of irrigation in the Jordan valley (O&M and capital costs). In these two scenarios, we consider that the actual block tariff system is maintained (cf. Appendix). Finally, based on a recommendation of THKJ (2004),[13] we will assess the impact of a hypothetical increase of up to 80% of the present average cost of water borne by farmers in the highlands, that is, about $0.116/$m^3$ (Al-Hadidi, 2002). In this third scenario, water is charged at a flat rate regardless of the total water used in the farm. (In the three scenarios, the rate of bill recovery is assumed to be 100%.) Table 10.7 specifies water costs for each crop and scenario and Table 10.8 for each farming system.

In Scenarios A and B, water prices are multiplied by a factor of 1.4 and 4.1, respectively, regardless of the crop planted. In Scenario C, and because of the implementation of a flat charge, water prices are multiplied by 8.5 for vegetables and citrus and by 5 for bananas. Table 10.8 shows that extensive farming systems (citrus and mixed farms) would be most impacted since water costs represent an important percentage of total costs (in citrus farms) and because their income is very low. On the other hand, intensive systems (greenhouse farms, for example) are not responsive to such policies since water costs are negligible compared to

[11]The JVA's revenue has decreased in line with declining allotments from 1999 onwards. This may have prompted the proposal to establish a monthly flat charge of JD2 ($2.8) on each water bill.

[12]In fact, since 2005, O&M costs are totally covered by the sale of water from the Mujib Southern Carrier to the Dead Sea industries. This recent change is not considered here in order to keep conservative estimates.

[13]'The water production cost from private wells borne by the farmers (at present about fils100/m^3) should be taken as a guideline for adjusting the water tariffs charged by the JVA (at present fils10–12/m^3). The tariff for 'public' water of the JVA should not be lower than 80% of the average cost of the water produced from private wells' (THKJ, 2004).

Table 10.8. Impact of different levels of water price increase on farming systems in the Jordan valley.

Farming systems		Open-field vegetable family farms	Entrepreneurial greenhouse farms	Citrus farms: Family farms	Citrus farms: Absentee owners' farms	Banana farms: Family farms	Banana farms: Entrepreneurial farms	Poor farmers: Mixed farms
Allocation type		Vegetables	Vegetables	Citrus	Citrus	Bananas	Bananas	Vegetables
Net income (US$/ha/year)		3800	7500	1250	400	7000	12,500	1050
Total costs (US$/ha/year)		8150	21,000	1550	1200	8200	8600	2400
Actual water costs (% of income)		1.8	<1	11	34.5	5	2.8	6.4
Actual water costs (% of total costs)		<1	<1	8.9	11.5	4.3	4.1	2.8
Revenue decrease (% of the actual income) according to three different water prices	A. O&M costs recovery	<1	<1	4.2	13.2	1.9	1.1	2.6
	B. Total costs recovery (O&M + capital costs)	5.5	2.8	34.8	negative revenue	15.8	8.8	20.1
	C. 80% of water costs borne by farmers in the highlands	13.6	6.9	82.7	negative revenue	19.8	11.1	49.4

input and labour costs, and they will remain so at any politically acceptable price level (Wolf *et al.*, 1996).

Scenario A would have a limited impact on most farming systems in the Jordan valley. Revenues in vegetable and banana farms would decrease by less than 1% and 2%, respectively. Poor farmers would also be slightly affected by the increase (2.6%). Finally, citrus farming systems would be the most affected: revenues would decrease by 4.2% to 13.2%. In the latter case, most absentee owners would probably retain their orchard because it is not central to their livelihood, or would adopt other trees.

In Scenario B, farmers' revenues would decline more substantially. Productive systems (vegetables in open fields or under greenhouses) would again be slightly affected (revenue is expected to decrease by about 2.8–5.5%). These farmers would probably cope with this loss or seek (limited) on-farm water savings through better management, in a bid to decrease overall water costs (see below). Mixed farms developed by poorer farmers would be substantially affected (–20.1%): some farmers might be driven out of agriculture, looking for jobs in other economic sectors, while their plots could be rented to and cultivated by more entrepreneurial farmers.[14] Profitability of banana orchards would be moderately affected (revenues decrease by 8.8–15.8%). Despite their high revenues, some farmers might shift to other very profitable orchards such as date palm trees that are less water-consuming, especially if import tariffs on banana are lowered. Finally, citrus farms would be greatly affected: profitability of family farms would decrease by one-third, while absentee owners' farms would no longer be profitable: citrus areas would be expected to decrease substantially with many small owners (shopkeepers, civil servants, retirees, old farmers, widows, etc.) renting out their land or shifting to higher-value trees, and only a small fraction of rich absentee owners retaining their orchards.

Finally, Scenario C would have a dramatic impact on the Jordan valley agriculture. As in the two previous scenarios, citrus orchards would hardly be profitable anymore and would basically disappear, with the same replacement options as above. In banana farms, a partial shift to date palm trees and generalization of drip irrigation systems might be observed. Mixed farm operators would see their profitability decrease by one-half and would tend to be replaced by more entrepreneurial farmers. In the end, profitability of vegetables planted in open fields or under greenhouses would decrease by nearly 13.6% or 6.9%. This third option is hardly imaginable politically and would disrupt the valley economy.

Are improvements in irrigation and economic efficiency possible at the regional scale?

Whether substantial water savings are possible is highly variable and depends on what the actual irrigation efficiency is and, if any low value is observed, on the causes of such a state of affairs.[15] Improvement of efficiency is hindered by several constraints, both technical and socio-economic.

[14]Since 2001, land market transactions have been allowed in the Jordan valley. Renting plots is also a widespread practice. As land pressure in this valley is very high, any plot left fallow by a farmer is expected to be taken up by another farmer with a more intensive management and higher profitability. The irrigated area in this valley is unlikely to decrease, whatever water prices are.

[15]Because of the high diversity of situations, available data on efficiency are rather inconsistent (Al-Zabet, 2002; World Bank, 2002; Petitguyot, 2003; etc.). This is due to the extreme complexity and variability of use efficiency, and to what is considered: which crop and what type of farm; the plot, pumping unit or the valley level; the water-short period or the whole year; which ET and Kc values; total or effective rainfall; special water requirements for specific operations such as 'solarization' and in occasional periods of deficit irrigation. All these factors combined explain why the literature is not fully consistent (Ghezawi and Dajani, 1995; World Bank, 2001a; World Bank, 2002; Shatanawi *et al.*, 2005; USAID, 2006; etc.). Our estimates of annual irrigation efficiencies give 64%, 62% and 82% for vegetables, citrus and bananas, respectively.

- First, farmers experience many technical problems at the farm level that come from drip irrigation systems which have been installed without technical guidance (in 70% of the cases), direct connection of old dripper lines to the JVA's pressurized network,[16] problems of filtration and clogging, etc. (Wolf *et al.*, 1996; Courcier and Guérin, 2004; Shatanawi *et al.*, 2005).
- Second, whether much water can be saved just by farmers being more 'careful' and with limited additional costs is doubtful in non-gravity irrigation. Experiments by USAID/JVA and MREA/JVA suggest that with precision irrigation it might be possible to save around 25% of water applied. This is easier to achieve in citrus farms irrigated by open microtubes. Achieving better irrigation efficiency requires computerized monitoring, use of tensiometers, improved filtration, frequent renewal of drippers, qualified staff, etc., and is therefore very costly. With the impossibility to expand cultivated land, the incentive for the farmer to achieve such gains is low, since corresponding costs are too high, regardless of the price of water. If we keep the estimates used for the highlands ($370/ha/year for achieving an efficiency of 75%, and an additional $1130/ha/year for reaching 85%) we can see that economies in the water bill will never come close to improvement costs, even for Scenario B.
- Only very high-tech and capitalized farmers linked to high-value markets demanding high quality of products can adopt and master such practices. It is important to note that, historically, drip irrigation was developed in the early 1980s as a technical response to the need to produce high-value products (along with the adoption of mulch, fertigation, labour-saving technology, control of doses, homogeneity and quality of products, etc.) rather than to a lack of water per se.[17]
- Third, farmers also experience many difficulties because of deficiencies in collective pressurized networks which result in a high heterogeneity of water distribution (with deficits observed in higher parts, sandy soils or at the end of the lines); rotations are difficult to establish; water theft, rent-seeking and tampering of equipment are pervasive (GTZ, 2004).
- Fourth, despite being conceived as a demand-based system, subject to the limitation of quotas, the actual mode of operation of the JVA and the uncontrolled nature of the inflow from the Yarmouk river do not ensure enough reliability in water provision (Courcier and Guérin, 2004). Overirrigation can also be considered as a safeguard against uncertainty in supply.
- Fifth, the system of monthly quotas defines a ceiling to the abstraction of pumping stations from the main canal (KAC): demand may be higher than the quota during a few critical periods in spring and autumn (Petitguyot, 2003), when no savings are possible. Conversely, efficiency is often lowest when supply exceeds demand, with no alternative use for water and therefore little rationale for saving water.
- Last, the desirability of further water savings is not fully established, as it is feared that lower salt lixiviation would raise salinity problems in the valley (McCornick *et al.*, 2001). (In the early 1990s, the JVA encouraged farmers to take water free of charge in the winter months for leaching purposes; Wolf *et al.*, 1996).

The idea that farmers are wasting water only because its price is relatively low is therefore simplistic and mistaken; so is its corol-

[16]Irrigation water is provided to farmers through several pressurized networks serving areas of approximately 400ha and pumping stations which draw water directly from the KAC.

[17]After the conversion of the open channel irrigation networks to pressurized systems (completed in the mid-1990s), which caused the reduction of the flow at the farm turnout from 20 l/s to 6–9 l/s, most farmers were obliged to shift to localized irrigation.

lary that raising prices will necessarily improve efficiency. A World Bank (2003) report indeed acknowledges that '[I]t was anticipated that increased water tariffs [of 1995] would reduce agricultural water use. This did not happen.'

Higher water charges also deplete incomes and, at least for low-value crops, tend to motivate shifts towards higher-value crops (Pitman, 2004; THKJ, 2004). Economic data in Table 10.8 suggests that, prima facie and as far as revenue per hectare is concerned, farmers would have an interest in shifting to vegetables or to high-value trees. Several points must be emphasized:

- First, although citrus (low productivity) and banana (water-intensive) may appear as undesirable there is little incentive for farmers to shift to vegetables (or to rent out their land to vegetable farmers) since they would then lose their higher quota with little hope of getting it back if they ever would like to revert to trees.
- Second, even if water prices were increased to cover all costs (Scenario B), banana farming would remain highly profitable and the shift to date palm trees (or other trees) not warranted (non-elasticity).
- Third, citrus would be made less attractive but large areas are owned by absentee owners whose livelihoods do not depend on their agricultural activity. Their orchards are linked to social prestige and recreational use and are not driven by economic motives. These owners may not shift to a more intensive and time-consuming activity for the sake of preserving their secondary agricultural revenue.
- Citruses in family farms are more likely to be replaced by more profitable trees (mangoes, guava, grapes, dates), or by vegetables, sometimes with the land being rented out to entrepreneurs. Yet these farmers have chosen to develop relatively extensive systems for a reason (lack of skill, capital, or alternative activities; ageing of farm-holder, etc.) and it will be difficult for them to shift to riskier, more intensive, and time-/input-consuming crops, unless market opportunities are identified.
- Last, it is worth mentioning that overestimating the capacity or willingness of farmers to adopt new crops or technologies and pushing for much higher water charges (Scenarios B or C) might lead to farmers responding to higher water tariffs by tampering with or destroying meters, bribery or defaulting. Unrest and political intervention would also be likely reactions. Such outcomes are not attractive for the government, which has little incentive to antagonize supportive segments of the society if gains are not expected to be substantial (Richards, 1993).

In conclusion it can be stated that all these elements strongly limit the scope for pricing mechanisms to achieve improvements in both irrigation and economic efficiency. Gains are possible but their magnitude and realization depend on the type of farm, and they cannot be obtained without support, including technical assistance, predictable water supply, secure markets, and subsidies to shift to drip irrigation (where this has not yet happened) and, gradually, to precision irrigation. Several alternative options have been proposed, along the following lines:

- Flexibility of water supply at the farm level is obtained not only through exceptional requests but also by digging farm ponds to buffer irregular supply (Shatanawi *et al.*, 2005), by using water from side-wadis and, wherever possible, by pumping groundwater. Many farmers already have implemented these options.
- Effective freshwater savings in the Jordan valley may come from the generalization of the use of treated wastewater blended with freshwater in the north of the Jordan valley, as proposed by ARD and USAID (2001b) (see also JRVIP, 2001b; McCornick *et al.*, 2002; and KfW *et al.*, 2006).
- Significant water savings could be achieved through a better in-season distribution of water in the KAC. With the

completion of the Wehdah dam on the Yarmouk river, it will be possible to have a more flexible management of water allotments (JRVIP, 2001b; Courcier and Guérin, 2004). Monthly quotas could be transformed into yearly quotas, with farmers keeping the latitude to distribute water along the year according to their needs (Petitguyot, 2003).

- With a more controlled water regime, it might be possible to adopt bulk allocation and bulk charging procedures, whereby water user associations would be in charge of managing a yearly amount of water and recovering charges (JRVIP, 2001a). This, however, is hindered by extant cultural and social structures and would require significant institutional transformations and changes in the agency(JVA)–farmer relationship (van Aken, 2004).
- The banana area could be reduced by substantially raising the price of the higher tiers of the quota so that revenue would be reduced without affecting other crops; it could also be made less profitable by removing duties on imported bananas, in line with WTO rules. Such economic incentives could contribute to inducing a shift towards other trees, but the potential loss of high banana allotments is likely to hinder this shift if no positive incentives are available.
- The most efficient way to reduce diversions to the valley (and to free more water for Amman) would be to gradually reduce quotas – as observed since 1999 – in order to force adjustments (high-tech management, change in crops, etc.). Additionally, a bonus might be granted to those who accept to shift from a high quota to the vegetable quota; of course, this would be hard to justify in the face of the recent contradictory measure of recognizing more citrus allotments.

The last point concerns cost recovery objectives: the analysis indicated that the prime objective of financial autonomy of the JVA is within reach. Charges could be slightly raised to ensure revenue, while defaulting should be controlled by stricter enforcement. Raising prices to full O&M costs would not dramatically affect farmers. It must be noted however that the 'fiscal drain' argument commonly raised to justify increased cost recovery is hardly convincing since the present O&M subsidy to the JVA is worth less than 0.1% of state expenditures at $3.7 billion.

Despite higher coverage of state-borne O&M costs, water charges do not instil any virtuous circle towards improved management and maintenance on both the manager and the farmer sides (Small and Carruthers, 1991). There is a lack of positive incentive stemming from the fact that charges paid by farmers do not benefit the scheme, managers do not depend on these payments (which are sent to the Ministry of Finance), farmers control neither part of the revenue nor water deliveries, supply is uncertain, and allocation not transparent enough. Under such conditions water pricing merely boils down to a taxation instrument. Bulk charging at the pumping station level and transferring responsibility for charging farmers individually to water user associations might be a way forward.

It is unlikely that raising fees much beyond O&M cost recovery can be tenable because of the limited effect on water use and the difficulty to justify charges higher than the JVA's expenditures, which would look like a transfer of wealth to the state. These factors and the fact that there is hardly any example of full cost recovery of public schemes in the world make Scenario B highly unlikely (not to mention Scenario C).

Discussion and conclusions

The results obtained in both the highlands and the valley have both similarities and discrepancies, and also bring out lessons that have wider validity.

Limited effectiveness of increased prices in instilling higher efficiency. Several modelling studies (Doppler *et al.*, 2002; Salman *et al.*, 2002; Shatanawi and Salman, 2002; Salman *et al.*, 2005 for the valley; Salman and Al-Karablieh, 2004 for the highlands) have shown that demand is only responsive to prices at levels which are in general not compatible with sustained farm incomes and equity. However, we have shown that the causes of efficiency losses are not all at the farm level and that further improvements require significant technological improvements which are costly and offset any gain derived from a reduced water bill (Pitman, 2004).

Consequently, the claim by the 2004 master plan (THKJ, 2004) that the full cost recovery for irrigation O&M pursued by the Ministry of Water and Irrigation will, among four objectives, 'increase conveyance system and on-farm water use efficiency' is not valid. From the correct assumption that 'low prices for irrigation water provide limited incentive to improve on-farm efficiencies' it is mistakenly inferred that raising prices will automatically improve on-farm efficiency and should therefore be 'a prime target for implementing improvements' (USAID, 2006). Despite evidence to the contrary, these claims are still pervasive among donors, development banks and some green NGOs (FOE, 2002). Removing public subsidies may have other virtues but should not be expected to bring about improvements in irrigation efficiency (or be justified by this).

*****_Intensifying agriculture: at what cost?_ Consequently, the principal impact of higher charges would be to reduce the income of two categories of farmers: poor and often indebted farmers with more extensive agriculture, on the one hand, and absentee urban owners and rentiers with other income sources, on the other. Such a pressure would have a beneficial impact if these farmers were encouraged to adopt more intensive farming. One should note, however, that these higher-value cropping systems were already available to these farmers and there are good reasons why – despite their high return – they did not adopt them earlier. Farmers engaged in extensive agriculture lack capital to embrace such ventures, which incur considerable risk; rentiers lack the interest to burden themselves with intensive management and value their farm for reasons other than their profitability. Intensification must be driven by market opportunities and not forced by circumstances which would drag de-capitalized farmers into risky ventures with a high probability of going bankrupt. It is doubtful whether the benefits of pushing the more vulnerable farmers out of business would be higher than the social costs incurred.

Most countries are confronted with this necessity of balancing family farming and agrobusiness, and social stability and economic efficiency (the case of Spain in Arrojo, 2001; Berbel *et al.*, 2005). As a rule, state policies include investments/subsidies to allow modernization of family farms in order to better compete with highly capitalized operators.

**High-value crops: for which market?* The move towards a more intensive and higher-value agriculture is critically dependent on the availability of a market for it. With growing competition from other countries in the Middle East it is not easy to identify crops with a good return: farmers are neither immune to drops in prices following a too widespread adoption of promising crops nor all ready for, or capable of, handling the complexity of certain productions. Palm trees, for example, are salt-resistant and dates (so far) fetch high prices, but they have several drawbacks which make them largely unfit for small extensive farmers: they do not produce during a period of 5 years, post-harvest operations are difficult to master, and only high-quality products find their way to the best market niches.

**The politics of water management and policy.* The negotiations around the by-law and the amendment, carried out with a fair degree of participation of stakeholders (Chebaane *et al.*, 2004), showed that agricultural interests retain significant political and bargaining power; the government is unwilling to alienate the support of Bedouin tribes or part of the Palestinian population, and to prompt claims from Islamist radicals that Islamic law is violated (Richards, 1993). The teeth of the by-law were removed through the implicit abolition of former abstraction limits (which were lower than the 150,000 m^3 threshold adopted) and through the recent amendment which abated the already low water fees. Some groups of influential farmers, with strong political linkages and opposed to a control of water abstraction, have tried to stop the process and have managed to slow it down thanks to support in the parliament.

The fact that illegal citrus orchards in the valley have recently been regularized – quite contradictory to policy objectives – also suggests that the populations concerned have enough political clout to counter the reduction of quotas. All this confirms that water pricing schemes largely reflect the political economy of a country and that political counterweights are often raised when prices depress incomes. This does not mean that reforms are not desirable or should not be attempted; but this cautions us against simple-minded decisions and forces decision makers to weigh benefits against all costs.

**Improving allocation of water resources.* With such a minimal expected impact of price increases on efficiency, the objective of reducing demand to sustainable levels in the highlands and to volumes lower than current diversions in the valley through pricing measures is clearly unattainable and must be dismissed, in line with Berkoff (1994), who recognized 'that it is inconceivable that [charges] would be high enough to balance supply and demand'. Under such circumstances, the higher-level objective of regulating intersectoral allocation through prices, expressed in the ASAL despite considerable doubt from experts (Pitman, 2004), is quixotic.[18]

**State and donors: conflicting viewpoints.* Opposition to pricing by most quarters in the government is based on three considerations (Pitman, 2004): (i) social concerns and the view that farmers' access to groundwater is already too costly; (ii) the view that administrative allocation of surface water and technical/institutional improvements in management are more efficient and equitable than pricing in achieving sound management; and (iii) the understanding that alternative markets must be ensured before pushing farmers to abandon lower-value crops. With some caveats this study tends to confirm these misgivings.

Pitman (2004) notes that the 'social-welfare dimension of water was the largest divergence of views between the Bank and government over the agricultural sector' and critically soured relationships. A possible source of misunderstanding is that affected people include both poor farmers and rentiers, and that the former might be used to unduly shelter the latter from adverse policy measures.

**Safety nets.* Policy makers' misgivings may be well founded if one judges from experience in other domains where planned safety nets have been neglected, equity impaired and social objectives defeated. For example, the elimination of all direct subsidies to owners of small livestock herds over the period 1995–1997 has proven to be very effective in reducing herd sizes by 25% to 50%, overgrazing, and thus rangeland degradation and desertification. However, an official evaluation found that 'the poorest group – nomadic pastoralists – in the driest areas have fared worst as they do not have the income to buy even subsidized concentrates. All farmers monitored, with the exception of the medium-sized agro-pastoral farmers in the wettest areas in 1997/1998, had negative profits since 1996' (Pitman, 2004). Earlier consensus that attendant measures would be needed seems to have been later forgotten (Richards, 1993).

This suggests that too little attention is given to safety nets and the assumption that people can be reabsorbed by the labour market without much hardship is often not valid. Clearly, linkages to the macroeco-

[18]The claim by the World Bank (2003) that 'the partial tariff increase [in the valley] satisfied an immediate objective of maximizing transfer of water to the highlands' has no basis since this transfer is a bureaucratic decision completely independent of prices.

nomic framework must be strengthened if social objectives are to be fulfilled.

**From negative to positive incentives.* Negative incentives through prices that deplete incomes or force costly/risky adjustments generally raise considerable opposition which may express itself through political channels or in the streets. Such (stick) measures must be accompanied with positive incentives (carrot) (Al-Weshah, 2000). Positive incentives include a bonus for uprooting olive trees in the highlands or for accepting vegetable allotments in the valley (or tree allotments for banana growers), attractive buyout schemes of wells in the highlands, aid or crop insurance schemes for farmers tempted to diversify, etc. The government's refusal to raise prices before treated wastewater or market opportunities are available also indicates the fear of negative impacts in the absence of clear alternative opportunities and 'pull' factors.

**Enforcement and monitoring.* It is clear in both situations that individual metering is extremely demanding and hard to administrate. The percentage of broken meters both in the highlands and in the valley is likely to rise again after replacement campaigns. If fees significantly affect the economic situation of farms they will also probably trigger defaulting, tampering or destruction of meters, social unrest and political stress at unprecedented levels, and corruption or collusion between officials and farmers (GTZ, 2004). This does not mean that metering should not be attempted but reminds us of the costs involved and of the possibility that other approaches could be adapted more (e. g. charges based on crop and area in the highlands, or defined and recovered at the level of the pumping station in the valley).

**Quotas and regulation.* As shown from other situations where scarcity is high and volumetric control possible (Iran, Tunisia, Morocco, south of France, Italy, Spain, etc.), quotas are invariably selected as the main regulation instrument. This is because quotas are generally transparent, equitable, easy to understand, and effective in reducing demand without impacting incomes. Their implementation on wells, however, requires a major enforcement capacity. Their main drawback is their limited capacity to adjust to changes in demand. The present case provides such an example, where inefficiencies arise from the disincentive they generate for citrus and banana growers to adopt less water-intensive crops. A careful downward adjustment of quotas, as implemented since 1999, is, however, effective in skimming off the 'slack'.

Although the two situations show many commonalities, the comparison also evidenced a few meaningful discrepancies. The first difference is the possibility offered to highlanders to expand their plots. This allows them to capitalize on possible water savings and to increase cultivated areas (and benefits) in proportion. Since they may benefit directly from their financial or managerial efforts it is more interesting for them to improve efficiency than in the valley, where the sole reduction in the water bill (sometimes complemented by gains in yields) offers a limited incentive, while benefits go to Amman in the form of increased supply. Second, quotas in the highlands are merely thresholds which can be exceeded at limited cost, while those in the valley are rigid and cap diversions (although informal arrangements may offer some way out). Third, water supply in the highland is very reliable because it depends on individual wells and compact networks; in contrast, allocation and distribution in the valley are much more complex both technically (regulation of the KAC, rotation between farmers within pressurized networks, etc.) and socially (practices are embedded in complex social and political contexts). This difference explains why efficiencies are higher in the highlands (with the additional benefit that return flows tend to return to the aquifer while in the valley they mostly go to a sink: the Dead Sea). In sum, water management is technically simpler in the highlands but enforcement and control are problematic, while the opposite is true in the valley, where quotas are effective in controlling water use but management is heterogeneous and a uniform efficiency hard to achieve.

APPENDIX. Current and proposed irrigation water tariff structure in the Jordan valley. (From FORWARD, 2000.)

Water quality	Usage block (m³/month/3.5 ha maximum)	Irrigation tariff (per 1000 m³)	
		Current	Proposed
Freshwater	0–2500	JD8 ($11.5)	JD15 ($21.6)
	2501–3500	JD12 ($17.3)	JD30 ($43.2)
	3501–4500	JD20 ($28.8)	JD45 ($64.8)
	Over 4500	JD35 ($50.4)	JD55 ($79.2)
Low-quality water	0–2500	JD8 ($11.5)	JD8 ($11.5)
(freshwater mixed with	2501–3500	JD12 ($17.3)	JD12 ($17.3)
treated effluents or	3501–4500	JD20 ($28.8)	JD20 ($28.8)
highly saline water)	Over 4500	JD35 ($50.4)	JD35 ($50.4)

In conclusion, we can observe that there is pervasive overenthusiasm about what can be achieved through pricing policies, and that policy objectives are often listed without due attention to the contradictions they entail and the trade-offs they imply. Expectations of the ASAL, for example, were high but the goals of economic efficiency, equity and environmental sustainability central to the definition of Integrated Water Resource Management are not easily reconciled. In both, the highlands and the valley, substantial increases in volumetric charges would not elicit major water savings but would further depress the income from low-value or extensive crops. A shift towards high-value crops would not only raise water productivity but also entail a transfer of wealth to the government and to wealthier entrepreneurs, an evolution which is so far not considered desirable or politically palatable by Jordanian decision makers. It is therefore essential that negative incentives be accompanied by positive measures offering attractive alternatives (market options, subsidies for modernization, technical advice, etc.) and exit options with compensation.

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