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Editorial: Issue and Authors

ADDRESSING DISJUNCTURES IN WATER AND IRRIGATION

The policy terrain surrounding water-related issues in South Asia faces the crises of equity, efficiency and ecology. The solutions proposed by its hierarchic hydrocracies have generally favoured supply augmentation through new construction. This approach neglects the constraints embedded in the very nature of water governance. The result has been the consolidation of sectoral approaches, with irrigation, drinking water supply, flood control, navigation, fisheries and hydropower generation considered in isolation. Solutions pursued within one sub-sector have often conflicted with those in others.

That disjunctures in the water management terrain exits has been recognised since the mid-1990. Since then, too, it has been suggested that integrated water resource management (IWRM) can attain the objectives of a holistic approach. The Global Water Partnership states that "IWRM is a process that promotes the coordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems".[1] The definition uses terms that are common place in debates about large dams, such as equity, sustainability, efficiency, participation and respecting the ecosystem. It implies that the conventional approaches have failed to address these issues which are central to the sustainable management of water and prevent the degradation of both the resource base as well as the communities dependent on them for sustenance.

The definition of IWRM begins with the term 'process'. What are its elements? How does such a process take place, within what social and political framework and who are the actors? Can outsiders introduce such a process or does it need to emerge from within the context of local water use and management? These are not merely theoretical questions; they must be addressed if IWRM is to be operationalised.[2] It must be recognised that each term included in the definition has multiple facets depending on where the interpreter is located in the social space. The notion of economic efficiency is an incentive for the individualist devoted to market institutions while social activists having an egalitarian bent champion equity and social justice. Ecosystems and the water flows, which maintain their integrity, are concerned with deeply held religious, aesthetic and riparian values that are in conflict with the approach that considers flowing water as a wasted resource that needs to be harnessed for monetary gains. The hierarchic organisations of South Asia and the construction fraternity that practices civil engineering continue to focus only on a strategy of control as well as on technologies that promote such control. Often, these practice fail to address issues of values that uphold things other than control or profit.

The term 'integrated' is therefore a misnomer that hides the central problem, which is how to bring all the elements mentioned above into the water policy terrain. What would allow this objective to be achieved? Water problems emerge, are resolved and dwindle in importance and the cycle without a doubt repeats itself anew in different times and places. The values of societies separated by space and time differ and it is incorrect to expect that there will be a consensus about proposed solutions regardless of where they may have been successful before. The key is not to set up etalons of 'best practices' to be imitated but to develop a society's inherent capacity to respond appropriately to water problems when and where they emerge.

Even within a specific society at a specific time, there are bound to be multiple perspectives on a problem, diverse but not necessarily infinite. It has been shown that providing space for a minimum of three active social solidarities—the conventionally-inclined hierarchic bureaucracy and individualistic market as well as the not-so-conventionally accepted critical social solidarity of 'social auditors'—is sufficient to pluralise the policy terrain. The way forward, the challenge of genuine 'integration' is, therefore, to ensure that the voice of each of these three perspectives is given a fair hearing. The nature of the engagement among the three is not going to be neat like the much-sought-after 'consensus'; instead it is going to be a series of clumsy iterations involving the cycle of learning, unlearning and re-learning. Perhaps the motto of statesmanship in such a terrain should be: 'Always learning, never getting it perfectly right.' With that 'democratic' attitude, one then moves into the realm of creative and vibrant engagement to be able to respond to water problems as and when they emerge in the fascinatingly diverse hydro-ecology of South Asia.

Fortuitously, the papers in this volume of *Water Nepal*, which cover the irrigation sector, address such diversity without the editors having intended it. Except for the viewpoint and the book review, the contemplation of those involved in irrigation research reflect the varied nature of the water terrain. Irrigation is the major user of water, often nationally and certainly globally. Since irrigated crops are the major constituents of the overall food system for humans and of their meat industry, they cover a wide range of the food chain including access, utilisation and availability. In this increasingly industrialised process, we need approaches that help to maintain ecological integrity and to protect ecosystems essential to maintaining livelihoods. At the same time, it needs to be recognised that water is also important for other productive economic activities, some of which are often at conflict with agriculture. Who or what would be the 'social carriers' of these diverse approaches to and perspectives on irrigation particularly, and water generally?

Olivia Aubriot explores agricultural data and water distribution techniques to propose a hypothesis about the history of irrigation in central Nepal. She places irrigation in its socio-economic context and shows how changes in the farming system at the beginning of

the 20th century had an impact on water management and water division techniques. Using the case study of the Aslewacaur canal in Gulmi District, she demonstrate that the construction of a farmer-managed irrigation system is not instigated solely by economic stimuli but by other factors such as state policies, too.

Sujan Ghimire looks at the irrigation policies of the government of Nepal, specifically the new Irrigation Policy of 2060, which acknowledges women as irrigators and formulates policies for promoting their participation in water management. This article attempts to understand the relevance of these policies in promoting equity for and the empowerment of women by exploring women's actual roles in irrigation. By reviewing literature on women's roles in irrigation, she also explores how women's issues have been conceptualised by various discourses on development.

Thomas Rutkowski presents a study investigating wastewater irrigation in Kathmandu. The first peer-reviewed study of its kind in Nepal, the results show that some farmers in the Bhaktapur area irrigate directly from sewers with untreated and undiluted municipal wastewater, while others irrigate with diluted municipal wastewater from rivers. In the Kirtipur case study area, a new type of wastewater irrigation is practised: involuntary flooding of wastewater. As wastewater is applied to crops, a natural treatment process takes place, and the water quality of the wastewater improves. This potentially positive aspect of wastewater irrigation is, however, difficult to exploit in today's Kathmandu Valley as the capacity of properly situated agricultural land to absorb the large volumes of wastewater generated by the burgeoning urban areas is insufficient.

Peter Mollinga explores the problem faced by the large-scale government managed canal irrigation systems of India and provides a critique of its water resource management discourse and practice. He shows how the discourse and practice reflect particular features of the society in which they exist, and how they fail to overcome the limitations caused by that embeddedness. His findings have implications for institutions, science and technology, and developmental practices which shape the contours of the domain of new approaches.

The paper by Jinxia Wang, Zhigang Xu, Jikun Huang, and Scott Rozelle is about irrigation reforms in rural China, where the shortage of fresh water is becoming a major environmental problem. It has affected irrigation practices and threatens to reduce food production. The authors analyse the process of management reform by focusing on the effect of incentives on these reforms. They have tracked the evolution of water management reforms, identified incentive mechanisms that encourage managers to use water more efficiently and demonstrate their impact on water managers. They highlight how changes in incentives affect a manager's reactions to water requirements of crops and, hence, ultimately to agricultural production, and the farmers' incomes and poverty status.

The viewpoint by Dipak Gyawali attempts to deduce general conclusions for collective action directed at addressing common water related problems in South Asia. It is an attempt

to theorise on the questions asked earlier about what is the process of integration that ushers in healthy water management. He suggests that water problems, especially those that pertain to social equity and environmental sanitation, are very local but the debates that characterise them socio-institutionally match the problems seen at the global level. The established approach to looking at water and its associated environmental and social problems is rife with institutional mismatches that end up defining the problems incorrectly and then suggesting inappropriate solutions. The trick, he argues, is to create a mechanism in society for constructive engagement among different solidarities by allowing all voices, especially those of social auditors that are often silenced, to be heard. This paper is based on the keynote speech Gyawali delivered at the 5th Global Civil Society Forum; organised by United Nations Environment Programme and the Korean NGO host committee for the 5th GCSF on 28 March, 2004, in Jeju, the Republic of Korea.

Ajaya Dixit reviews Ramaswamy Iyer's book *Water: Perspectives, Issues, Concerns*. He suggests that Iyer's book will be helpful in penetrating through to the inherent contradictions in South Asia's water policy terrain. Tracing the evolution in Iyer's thinking, Dixit explores the contours of a newly developing paradigm that is more sensitive to social and environmental concerns.

As was the case with past issues of *Water Nepal*, we hope the views presented in this issue will help water scholars in South Asia and further afield to address the growing challenges of water management in the 21st century.

– Editors

NOTES

[1] This definition of IWRM is provided by *Global Water Partnership Technical Advisory Committee, 2000: Integrated Water Management, Stockholm, Global Water Partnership*, p. 71.

[2] These questions are also dealt in our earlier publication, *Fluid Mosaic, Water Governance in the context of Variability, Uncertainty and Change*, which was first released in 2003 at the Third World Water Forum in Kyoto. In June 2004 issue of *Water International* Asit Biswas has argued that "the definition of IWRM continues to be amorphous, and there is no agreement on fundamental issues like what aspects should be integrated, how, by whom, or even if such integration in a wider sense is possible".

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VIEWPOINT

WATER, SANITATION AND HUMAN SETTLEMENTS: CRISIS, OPPORTUNITY OR MANAGEMENT?

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ABSTRACTING FROM DIVERSITY

Water problems are as diverse as the human settlements that depend on water availability. In a region as large as Asia, the number of water-related problems is so vast that it is impossible to engage with any crisis, whether flood or drought, pollution or displacement, without paying homage to water. The region spans every known climatic and hydro-ecological zone, including deserts, tropical floodplains and tundra. The challenge of providing varied human dwellings in such diverse habitats with safe and reliable water, for both human consumption and economic activities promoting general well-being, will have to engage the sum total of known global ingenuity.

Despite this diversity, it is necessary to identify and address common problems if we intend to forge any intelligent plan for collective action to solve water and settlement-related problems. This effort will require us to step back from specifics, which are different in every hamlet and town in every clime, and deduce general lessons. It is precisely in drawing such lessons that those of us engaged in redressing social or environmental wrongs face our biggest challenge. Water problems, especially those that pertain to social equity and environmental sanity are often very local concerns that demand actions at the local level, but regional and global cooperation on such local issues are difficult to define unless the problems have been generalised for a global audience. This generalisation is not an easy thing to do, but without it, no agreement is possible on how to proceed forward with collective action.

Social and environmental activists are intimately in touch with their grassroots and they function most effectively in local situations. But, in all honesty, they are not very effective at the global level where they have to confront problems abstracted to several levels above the grassroots. Often, activists find themselves confronting a situation in which the issues that they have dealt with at the field level have been re-cast in such a manner that they are hardly recognisable. In some cases of resetting, sharp multinational

businessmen or their even sharper brethren in international bureaucracies will have already hijacked grassroots concern to suit their agendas. While it may be deeply self-satisfying to fulminate against them (as activists are prone to) denunciation alone will not push forward the common agenda of social and environmental justice.

This essay addresses the business of deducing general conclusions for collective action. The effort first requires addressing the process of defining the problem itself, which, perhaps unwittingly, pre-determines what the possible solution might be. It argues that the currently established approach to looking at water and its associated environmental and social problems is rife with serious flaws: the very definition of the problem is partial and biased, and hence attempts to rectify the malaise within such a paradigm lead to more problems in the future. Let us examine this hijacking of development through a few cases captured by the following examples.

TRAGI-COMEDY ON THE TINAU

Figure 1 depicts a traditional irrigation diversion technology in Nepal and many other parts of South Asia—the brushwood dam (this particular one is on the Tinau River in Palpa District's Maadi Phaant below the town of Tansen). The volume of water in the thousands of streams that crisscross the land can differ by a thousand times between the dry and the wet seasons. In the dry winter months water for irrigation is in short supply but during the monsoon there is too much water. Designing a concrete diversion structure capable of functioning during both extremes would be prohibitively expensive. Unlike engineers who design permanent structures, farmers have perfected an adaptable technology—the 'disposable dam' that allows a stream to be diverted to fields during the dry season but is washed away during the monsoon to allow floodwaters to drain off. The material (mostly bamboo, brushwood and clay) and the skills needed for construction can be mobilised at the community level.

FIGURE1
BRUSHWOOD DAM ON THE TINAU (TRADITIONAL TECHNOLOGY)

However, today's market pressures have introduced new difficulties in mobilising voluntary labour: when off-farm labour provides cash benefits, the rural underemployed are naturally reluctant to work for free even for their traditional community schemes.

To manage and operate their traditional 'brushwood dam'—based water diversion schemes more effectively, what the community needs are some small mechanical excavators, sheets of impervious material and other similar enhancements that require neither large investments nor highly specialised skills for operation.

Unfortunately, what they got instead is the tragic-comedy shown in figure 2. This photograph is that of the infamous Hattisunde barrage on the Tinau near the mid-western Nepali town of Butwal. As in the upstream Maadi Phaant, this region too is replete with brushwood dams that divert streamflow in the dry season to fields growing paddy, wheat and other cash crops. This 'modern' barrage was built with Indian aid in the early 1960s on the debris fan of the Tinau River as it debouched onto the Tarai plains. The barrage was designed and built to irrigate land in Marchawar about 30 kilometres to the south of the structure. The irony was that Marchawar was already irrigated by a traditional 'brushwood dam' at a place called Gurbaniya, which was built by mobilising hundreds of farmers as voluntary labourers. Those behind the initiative to build this 'modern' barrage were the local landlords of Marchawar. It had become impossible to mobilise mass voluntary labour in a coercive manner during the less repressive, post-Rana democratic environment in the country. The comedy lies in the fact that the year after the barrage was built, Mother Nature decided she did not like it: the entire river shifted to the right, leaving the barrage high and dry so the farmers of Marchawar received no water from this modern structure.

The tragedy that followed resulted from the fact that the government did not re-build it. Worse, their traditional canal systems based on the 'brushwood dam' at Gurbaniya, were carved up by the distribution canals laid with this barrage project. The old canals were an intricate system, which had gradually evolved over the years to allow for rotational water sharing among complex, quilt-patch plots of ownership. They were perfectly suited to deliver irrigation water with equity, but the new grid-like system had completely ignored issues of land ownership. They had imposed a Cartesian, grid-like canal system on the farm plots and would have been incapable of supplying water in a socially acceptable manner even if the river had not moved away from the barrage. The end result of this experiment in development was that the social order in Marchawar broke down as desperate villagers began to resort to whatever means to survive.

FIGURE 2
TINAU RIVER BYPASSES BARRAGE
(MODERN TECHNOLOGY AND ITS INAPPROPRIATENESS)

FIGURE 3
VILLAGERS COPE WITH ALTERNATIVE TECHNOLOGY[1]

For the next twenty years, the area became infamous as a dacoit-infested region.

Slowly, as shown in figure 3, the local market entered the picture and provided farmers with cheap technology to pump groundwater. Hand and diesel pumps are ubiquitous across South Asia, the estimated number of diesel pumps in India alone being some thirty million. Like brushwood dams, pumps are a flexible technology, easy for the villagers themselves to operate and, unlike the concrete barrage, they lie within the risk-resilience capacity of farmers to cope with if something goes wrong. Unfortunately, one finds few water engineers working to improve brushwood dams, few government departments helping farmers with institutional means for sane and equitable groundwater pumping, and few engineering colleges teaching and training upcoming water management professionals along these lines.

WRONG DEFINITION OF THE PROBLEM

This story of a local water problem in the Tinau basin from genesis to impasse is not unique. It starts with a problem wrongly defined and thus inappropriately solved by the powers-that-be. Some disaster, social or natural, then compounds the pre-existing difficulties. After the initial media attention has died down, a period of benign neglect by authorities follows, and villagers with severely depleted self-reliant coping mechanisms find it impossible to restore their old system or build a new one. Similar examples of farmers losing their capacity to cope and lapsing into fatalism are probably found in many neighbourhoods elsewhere in the world.

In a general sense, the list of problems associated with water is inexhaustible. There are problems of quantity, quality, access, allocation between competing users and uses, fairness in these allocations, and so on. Water, the essence of life, has various properties that are exploited at different times by different groups of people to different ends. Its biological properties make it vital to plant and animal life; its chemical properties, which ensure its being the best universal solvent, are essential to the industrial process; and its physical capabilities of energy transfer and easy flow make it indispensable for power production as well as city sewage management. Its contact with, and flow through, the landscape provides it with self-

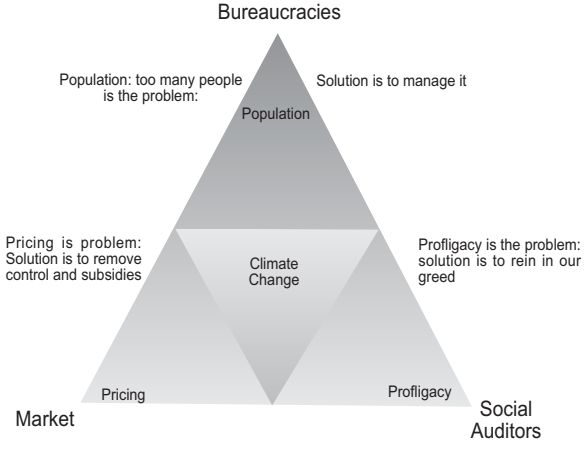
cleansing properties (within limits). And water also has symbolic properties that different human societies across the planet value for religious or aesthetic reasons. It is the multiple permutations of these and many other issues that make the task of supplying water to various settlements unique, and perhaps institutionally daunting.

Water is not just a subject but the intersection of many subjects taught in a university. It has been the subject of engineering (mostly civil) and some economics, but it is also an issue for sociologists, lawyers, geological and atmospheric scientists, and—given the strong emotions it arouses—poets, writers and philosophers of ethics as well. Unfortunately, there has been excessive civil engineering and economics associated with water resource development and too little involvement of the other disciplines, many of which have not bothered to sufficiently investigate water from their perspectives. This neglect has denied activists—and society at large—convincing holistic arguments in favour of saner alternatives to those currently pursued. To elucidate this point, let us examine how different groups define the same predicament as very different problems.

As an illustration, let is take an example from another globally contentious but related environmental field—climate change. The three main social solidarities—national and global bureaucracies (hierarchies), markets (individualism) and civil society, which some of us have chosen, in our research, to call 'social auditors' (egalitarians who are also the voice of caution)—see the same human predicament of global climate change in three very different ways.

To the hierarchs the problem is too many *people* and the solution lies in implementing measures to control them through family planning and various other regulatory means. If there were fewer people, they would certainly emit far less CO_2, goes this argument. To

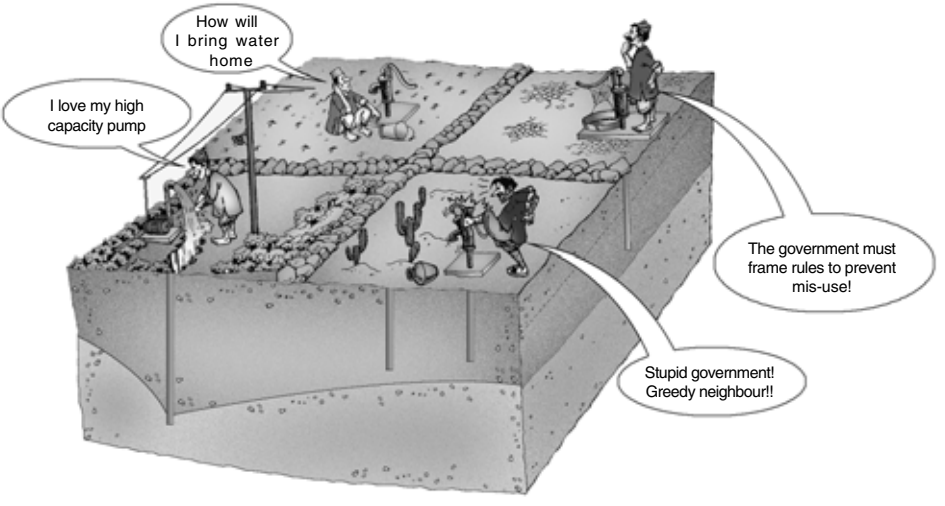
FIGURE 4
MULTIPLE DEFINITIONS OF A COMMON PROBLEM[2]



the individualistic markets, 'too many people' has never been a problem; rather large population provide equally large opportunities to sell more goods and make bigger profits.[3] According to their view, the problem of climate change stems from unsuitable *pricing* policies and distorting subsidies of the wrong kind. These misguided policies do not provide the right incentives that would allow them to innovate and produce solutions to get the world out of this quandary. The egalitarian solidarity of social auditors sees the problem of climate change in yet a third way as *profligacy*, not population or pricing: we are too greedy, or, as the Gandhian egalitarian *mantra* has it, the earth has enough for our needs but not enough for our greed. Egalitarian critics argue that the procedural champions and regulatory fetishists in the bureaucracies, who forever argue in favour of rules and procedures, as well as the individualistic markets that are only egocentrically concerned about profits, are both wrong. On the other hand, the bureaucrats and the individualists accuse the environmentalists of being alarmists who only criticise but do not provide alternatives.

South Asia's groundwater overdraft problem (figure 5) demonstrates the multi-fold social response to a common quandary. It also includes the fourth social solidarity, the fatalistic masses, which are often at the receiving end of the strategies of the other three.[4] Individualism only sees comfort and profit for itself and thinks nothing of using more powerful pumps to draw down the water table. Hierarchic (bureaucratic) proclivities tends towards framing procedure and guidelines, while egalitarianism tends to fulminate against

FIGURE 5
SOCIAL RESPONSE TO GROUNDWATER OVERDRAFT[6]



both hierarchism and individualism. The fatalist feels helpless and can only cope with whatever is meted out.

Multiple responses to a problem event are seen in the case of siltation of the rivers and canals of the Indian state of Bihar. To the hierarchic Department of Water Resources, silt of the Kosi River is a problem to be controlled by a high dam, building which whose construction depends on the high-level expertise the Department alone possesses. To the egalitarian Ganga Liberation Campaign, silt control is a danger to be avoided, especially since the controlling structure, the high dam could burst and wreck great havoc. To individualist *zamindar* landlords, silt is an opportunity: if a high dam is built to control it, they would be sure to bag some lucrative contracts, but if it is not built and the canals are clogged with silt, they would get the contracts to clean them up. To the fatalistic *ryots* (peasants), silt, like Mother Nature, is a capricious thing that they just have to cope with one way or the other.[5]

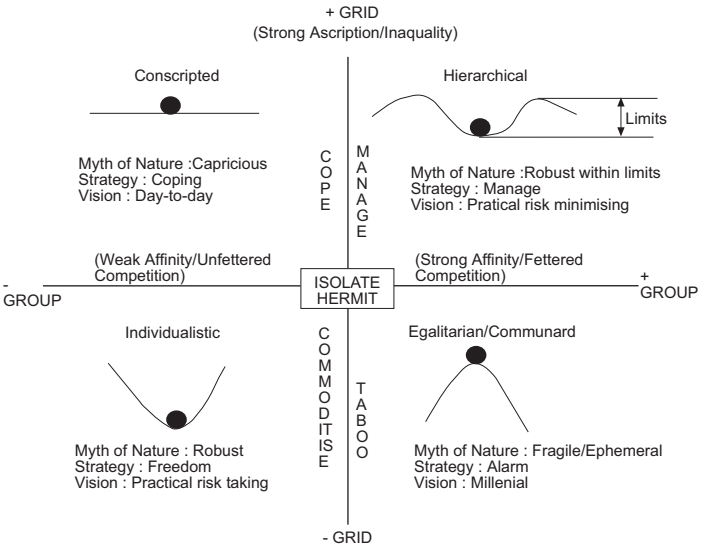
DIFFERENT PERCEPTIONS OF RISK

The important thing to realise is that the way in which these social solidarities are organised determines their view of the environment, their definition of the problem, their risk perception as well as their management styles, and the way they frame solutions. Where markets, which are risk-taking, wish to commoditise the problem in order to create opportunities for innovative solutions, risk-managing hierarchs want to control them with rules and regulations, and risk-averse egalitarians often fall for the easy solution of rejection and taboo to deal with the crisis. Fatalists are risk absorbers, without whose consent none of the strategies of the other three would be implementable.

As shown in figure 6, how a solidarity is organised also determines its view of nature and what should be done with it. Egocentric market individualists tend to believe that nature is robust, like a marble inside an infinite cup, and will take care of herself. No matter how much one pushes the marble up the cup, it will oscillate back to the stable bottom. Hence one should have no qualms about building high dams, nuclear power plants, sky scrapers, underwater cities or perhaps even colonies in outer space, for that matter. The activist holds the opposite view, believing that nature is fragile, like a marble perched precariously on top of a football, ready to fall off at the slightest stress. Critique and taboo are this solidarity's best strategies to preserve the group boundary delineating the true believers from the heretic outside.

The managers—the hierarchic bureaucracy—have to balance the totally divergent views of the egalitarians and the individualists so as to maintain some semblance of control. They do this by seeing nature as a marble inside a cup but not an infinite one: if it is pushed within limits—ostensibly set by laws, environmental impact guidelines and

FIGURE 6
A FRAMEWORK OF SOCIAL SOLIDARITIES



procedures—its condition will return to equilibrium. It is acceptable to build high dams, argues this solidarity, only if the expertise-approved procedures have been correctly followed. The poor fatalist, in contrast, believes that nothing he or she does matters at all. Nature is capricious: it goes any which way, like a marble on a flat table, and all that can be done is to cope with what is meted out.

It is important to realise that no one solidarity can be excluded from the policy terrain without detriment to all the others. This is because each definition of a water problem is correct, but only partial; and a policy based on partial views is bound to fail as unexpected surprises crop up. The presence of all conflicting (and maybe even contradictory) views is crucial in the overall policy arena if a society is to make sound judgements regarding its future.

Today, with hindsight, we can see that many of the major water fiascos around the globe have been the result of a single definition of the problem and a single-minded pursuit of 'the only solution.' Whether they be flood control embankments in the North Ganga plains of Bihar, trans-basin water transfer or high dams, the issue is not 'big' or 'small' but whether the risks involved—which are socially constructed—are big or small. Moreover, it is important to understand risk not just in technocratic term but also in terms of the different social solidarities that have varying perceptions of it. All concerned must democratically assess these perceptions.[8] For example, in the tragic case of Bihar's flood

control embankments, pursued as the *only* solution to the flood problem by the hierarchic environment, more land has now gone out of production due to the waterlogging caused by these embankments than has come under irrigation through infrastructure built in the State since India's independence.[9]

Alternative solutions to achieving security from flooding would have been cheaper and environmentally more beneficial, but were never pursued in the single solidarity policy terrain of hierarchs. Among these are many traditional practices such as building houses on stilts, raising the plinth level of village housing, crop insurance, etc., which market and activist solidarities now advocate. The very sciences of different solidarities, their framing of problems, the questions they ask and the areas they look into for answers are different. This is true even of the social science advocated by different social solidarities. The profit-making market trusts economics with its thrust on the efficiency with which profits can be made. Bureaucracies with built-in procedural fetishism prefer law, which frames rules and regulations specifying who has the right to do what to whom and how. The critical solidarity of the egalitarian activists often thinks laws are unfair and efficient corporations rapacious; they prefer the questioning discourse of anthropology over the other social sciences.

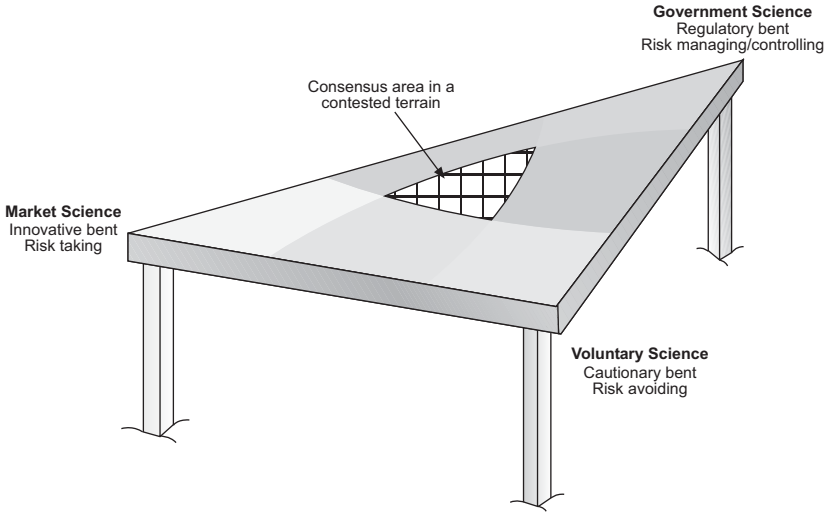
DEMOCRACY AND POLICY CONTESTATION

Since the definitions of a problem vary from a social solidarity to the other, can we even ever hope to find the 'right' solution? The examples discussed above suggest that we should not be looking for 'a' solution at all.[10] Because there are at least three different solutions (one from each of the three active social solidarities), the trick is to see:

a) if there are overlaps in the solutions proposed which could serve as a point of consensus among the differing definitions;
b) if the social solidarities are constructively rather than destructively engaged with each other; and
c) if the proposed solutions are inflexible (and hence vulnerable to nasty surprises) instead of being open to adaptive improvements by people themselves at the local level without depleting their 'risk resilience'.

Figure 7 is an attempt to capture the contested policy terrain where risk-managing governments practise a control-oriented approach that promotes one type of technology; risk-taking businessmen practise another; and risk-averse egalitarians propose still something else. If the three are constructively engaged, they could discover an area of consensual stability in the centre, which is less than what each would have individually liked to have, but is more than the nothing they will have if there is a destructive impasse.

FIGURE 7
CONTESTED POLICY TERRAIN[11]



Because risk perceptions about the problem of water supply to human settlements vary, we must also consider the question of technology assessment. Since different solidarities frame problems differently, the technological solution one prefers will differ from what the others may find desirable. It was fashionable some decades ago to talk of 'technology assessment', but experience has shown that a full assessment of the possible future impact of any technology is not possible. There will always be significant unknowns and uncertainties, which, as different solidarities construct their risk perceptions, will evoke very different responses. The trick, therefore, is not to hope for a comprehensive assessment of a proposed technology's impact: much of it cannot be known until it is implemented, and when implemented, it is too late for some technologies to be retracted (a high dam or a nuclear power plant, for instance, compared to a solar water heater or a biogas plant). The trick is to find out if the technology is flexible and capable of adjusting to the learning curve or if is it so entrenched and inflexible that it cannot be adjusted or corrected along the way.

To do this, we can identify the indicators of inflexibility, both social and technical, inherent in any proposed technology. There are four technical indicators:

- Large scale (small may not always be more beautiful, nor large necessarily ugly, but the larger the proposed scheme, the greater will be the risks involved)

- Long lead time (some proposed schemes entail a construction period of several decades, more than many times the life of several parliaments: who or what will carry on the social consensus in such a context and how will investors develop the required confidence?)
- Capital intensity (once you are locked into a one-hundred-million-dollar project, it is more difficult to adjust or move out than if you are implementing a one-million-dollar project)
- Major infrastructure needs early on (some schemes demand as a precondition other equally difficult schemes—a hydroelectric project might demand long road, for example).

The four signs of social (or institutional) inflexibility are as follows:[12]

- 'Single mission' outfits (if the mandate of an institution is to build dams – instead of a broader mandate of 'water management'—for every problem it will see a dam as the only solution)
- Closure to criticism (its definition of 'national security' for instance can include that outfit's version of development, which if challenged, will lead its opponents to being branded 'anti-nationalists')
- Hype (as in 'we will be Asian leopards if not tigers', or 'the sun will rise from the west' if a high dam is built[13])
- Hubris (overconfident declarations that 'there is no alternative' or 'we have all the answers' or 'who are you? we have all the best experts!')

If the technical and institutional indicators of inflexibility are present in significant numbers in any proposed technological scheme, we should exercise extreme caution in implementing it. Many environmental and social problems have arisen in the course of implementing water resource projects precisely because fools—and the unscrupulous—have rushed in where angels feared to tread.

ADAPTIVE STRATEGIES

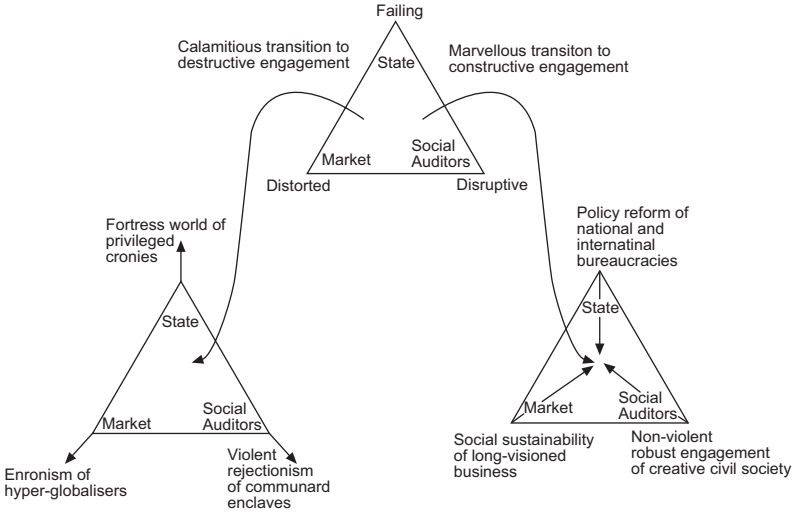
After a major stress such as a flood or an earthquake, both nature and society change. Instead of trying to restore the *status quo ante*—the bane of most disaster relief and rehabilitation measures—if effort as spent in trying to find out what the people were doing to adapt to new circumstances and helping them do so much better, the results would be much more beneficial to both the relief providers and the recipients. Recent research has indicated that, in the aftermath of a disaster, efforts to rehabilitate a settlement and its

infrastructure, including roads, schools and water supply schemes, are more successful if a different strategy is followed than what is conventionally attempted. Disasters are also institutional windows of opportunities to rectify chronic ills through catalytic changes.[14] The approach of 'adaptive strategies' holds that the users probably know what is best for them, more than the designers of grand 'master plans' in faraway capitals. There is space to help users do whatever it is they are doing much better, with longer-term vision, if the managers in power are open to listening to the voices of social auditors.

This pluralistic approach forces us to acknowledge that the policy terrain is contested among the various social solidarities. In this terrain, if the engagement among them is constructive, we can expect a stable area of consensus where not everyone may get everything he or she may wish for, but all will certainly get something. It means a world where business leaders ('mahajans' or 'great people' of society) are committed to social sustainability and hence imbued with long-term vision instead of short-term profits. It requires a creative civil society that is prepared for robust engagement with the powers-that-be with non-violent means. It assumes that national and international bureaucracies would be open to change, reforming their policies in view of what the markets and their critics have to say.

If the engagement is destructive, no one will get anything except impasse at best and conflict at worst (see figure 8). Markets would be rapaciously short-sighted, their

FIGURE 8
CONSTRUCTIVE OR DESTRUCTIVE ENGAGEMENT BETWEEN SOCIAL SOLIDARITIES



philosophy regressing into the 'Enronism' of hyper-globalisers. Civil society would degrade into conspiratorial enclaves that self-justify violence. And an increasingly uncreative state would exhibit a fortress mentality, relying on repression to hold onto power. Water projects, undemocratically selected and forcibly implemented, have shown some of the worst traits of destructive engagement in a society heading towards a stifling fortress world.

The future demands that we make the transition to a constructive engagement between the different solidarities constituting our body politic because the world that our children will inherit—if our engagement today is—is too horrifying to even contemplate. To assure a constructive engagement, the first need is to assure that all voices are heard, and the second is to provide the weakest voice (or the weakest leg, which in many cases is that of the social auditor/civil society) that extra space, a microphone, so that big players do not shut them out. This can be done either by a facilitative welfarian state or enlightened business leaders, or both. That would be statecraft at its wisest; and there are enough examples around the region that show how such 'constructive engagements'—especially in the field of water resources management—do ensure a win-win situation for all.

NOTES

[1] Figures 1, 2 and 3 from Gyawali and Dixit (1999)

[2] For details see *Institutional Frameworks for Political Action*, chapter 5 in Rayner and Malone (1998).

[3] Going back almost a quarter of a century, one can recall the common refrain among American businessmen about China's economic liberalisation: 'one billion consumers' went the wide-eyed scramble for opportunities. It is quite interesting to reflect on the institutional filters that prevented them from seeing what they today complain of: one billion producers!

[4] The three social solidarities of the hierarchic bureaucracy, the individualist market and the egalitarian social auditors are 'active' solidarities in that they cognise and strategise as per their inherent proclivities. The fourth, fatalistic solidarity—that of the broad masses—does not itself strategise but is acted upon by the other three. If they strategised themselves, they would no longer be fatalists. Their passivity does not mean that they are thus unimportant. They are risk absorbers and can withhold consent from the other three—as happens during elections or consumer boycotts—much to the detriment of the strategies of the other three.

[5] Dixit quoted in Chapman and Thompson (1995)

[6] From Dixit (2002)

[7] Adapted from Douglas (1992)

[8] Some of them, in the context of South Asia, have been discussed in Gyawali (2003)

[9] See Gyawali (1999)

[10] The new social sciences attempt to apply the conclusions of several centuries of socio-anthropological studies of so-called 'primitive' societies to the study of so-called modern societies in order to explain generalised pattern of global human behaviour. Some of the classical references for this approach are: Thompson, Ellis, and Wildavsky (1990); Thompson (1996); Douglas (1992); and Ellis and Thompson (1997).

[11] See Gyawali (2003), *ibid*.

[12] Both sets of indicators, technical and social, are from Thompson (1994).

[13] These are actual statements made in Nepal's parliament during the hyped up debate leading to the ratification of the Mahakali Treaty, which envisaged the building of one of the world's highest rockfill dam on the Mahakali River.

[14] See Moench and Dixit (2004).

[15] From Moench *et al.* (1999), ibid.

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FEATURES

IRRIGATION HISTORY IN CENTRAL NEPAL: THE INTERFACE BETWEEN AGRICULTURE AND TECHNOLOGY

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ABSTRACT

This paper summarises agricultural data and water distribution techniques collected in Gulmi District to propose a hypothesis about irrigation history in central Nepal. It places irrigation in its socio-economic context and shows how changes in the farming system, which took place in the beginning of the 20th century had major impact on water management and water division technique. All irrigation systems built during this period required major construction work and defined rights to a share of water. The changes intensified agricultural succession and the individualisation of space management. The story of Aslewacaur Canal demonstrates that the reasons for establishing of a farmer irrigation system were not simply economic.

When I encountered the story of the irrigation system of Aslewacaur[1] in Gulmi District, it seemed logical to place it in the context of the history of irrigation in central Nepal.[2] The main canal of this hamlet was dug at the end of the 19th century at the initiative of a single farmer but had been out of use for 18 years. He had initially obtained the support of three families, but they later withdrew because other villagers did not support the venture. The canal fell into disrepair without any action being taken until the initiator approached the government for help in repairing it. I wonder how the absence of village support when the policies at that time encouraged the construction of such canals could be explained. Even more puzzling was the collective disinterest, which is all the more striking today because it contrasts so sharply with the pride present-day farmers take in this project. In order to understand this peculiar situation, I had to explore the socio-economic realm of the period. Local factors, such as environmental conditions, social history and the political context, played key role. This paper covers only the general features related to agrarian history and techniques of water division. It demonstrates

that the evolution of the farming system in the beginning of the 20th century affected, on the one hand, the role of irrigation within the farming system and, on the other, irrigation management. I also show how water division techniques reflect the evolution of water distribution.

Reconstituting of the history of irrigation in Nepal is difficult because, as for other fields, very few written documents are available, except those related to Kathmandu Valley. The latter cannot, however, be taken as representative of the country because the Valley's agricultural system is unique: for a long time its cropping pattern has been intensive, there has been little possibility for expanding the area under cultivation and the use of cattle was secondary (Dollfus *et al*., 2003). Westerners who lived in Kathmandu in the 18th century provide very little information about regions outside the Valley. Mahesh C. Regmi's work on the history of land tenures is the most relevant document.

In order to palliate the absence of written documents, this paper relies on local stories related to the farming and irrigation systems and techniques used in Gulmi. Two functions of irrigation are distinguished in the first part and irrigation development history gets a new perspective in the second part. Placing irrigation in the context of the history of the farming system reveals the impact changes in this system made in the beginning of the 20th century had on water management. A discussion of this change composes the third section of the paper.

THE IMPORTANCE OF IRRIGATION IN NEPAL'S MIDDLE MOUNTAINS

In the middle mountains of Nepal,[3] the objectives of irrigation are primarily providing water to *khet* for paddy cultivation, and, once water is available, attempting to intensify agriculture through multiple cropping.[4]

Paddy field irrigation

The main purpose of irrigation in Nepal's middle mountains is to supply water to cultivate paddy in *khet*, or levelled and bounded terraces. The technique used, known as wet rice growing, is characterised by having water cover plots of land during the major part of the growing season (Abé, 1995). Although rainfall is abundant during the monsoon, wet rice cultivation requires some supplementary water, which is supplied by canals.[5] This technique is different from the dry or rain-fed method of rice cultivation (*ghaiyā dhān*[6]), which depends entirely on the rains for its water supply and takes place on unbounded fields. This difference results in a dichotomous classification of land depending on its capacity to cultivate wet rice. '*Khet*' designates a wet-rice terrace, even though wheat, potato or maize is cultivated on it during the winter and/or spring, while '*bāri* or *pākho*' is the term used to designate sloping un-terraced fields.[7]

Various types of paddy fields, which are distinguished by topography and access to water are differently designated in the vernacular terminology. *'Kholā khet'* names terraces located along the banks of small rivers; '*phā̃ṭ khet*' occupies the floor of wide valleys or alluvial basins (*phā̃ṭ*); '*ṭār khet*' are perched alluvial terraces (*ṭār*); '*pākho khet'* is land on the lower slopes of a mountain (*pakho*); '*bagar khet'* are alluvial paddy fields built with flood waters (*bagar*); and '*sim khet*' is land which is constantly watered because of its hydromorphic soil (*sim*).

Parajuli (1999) bases his typology of the irrigated systems of central Nepal on their geographical location and the local terminology for paddy fields. He describes the hydraulic characteristics of the networks and analyses the agronomic and social consequences of each type. He mentions three categories of terraces: foothill terraces (*kholā khet*), slope-hill terraces (*ṭār khet*) and river-valley terraces (*phā̃ṭ khet*) (*Ibid*). He includes terraces located at the lower slopes of mountains (*pākho khet*) in the category of '*kholā khet*' that weakens the range of his analysis. While *pakho khet* certainly depend on a short conveyance canal, they can be supplied by other sources and, they require greater control during construction and management than *khola khet* do. This last observation is inspired by the work of Abé (1995), whose typology of paddy fields in Asia is based on hydrological criteria (water availability and movement) and hydraulics (the type of control infrastructure used).

In sum, using hydraulic and topographic characteristics, four main types of paddy fields can be distinguished: *kholā khet, phā̃ṭ khet*, *ṭār khet* and *pākho khet*.

Intensification of agricultural succession

In recent times, irrigation in the low and middle mountain regions has enabled farmers to cultivate up to three crops a year (usually rice, wheat and maize), but this was not always the case. Earlier, paddy and sugarcane were the irrigated crops. Field investigations in central Nepal reveal that even maize might have been cultivated on *khet* only in the beginning of the 20th century. This was, for example, introduced in the village of Argeli in Palpa District between 1910 and 1920 (Yoder, 1986). In 1992 an eighty-one-year-old notable of Ridi in Gulmi District explained that prime minister Chandra Shamsher had introduced maize seeds to Palpa and Gulmi districts in 1918.[8] The testimonies I collected in Aslewacaur do not, however, confirm this date. Some elders born in 1904 remembered seeing monsoon rice and maize planted on *khet*. One villager affirms that in 1918, maize was cultivated on the *khet* of Aslewacaur after rice, mustard and buckwheat, respectively, had been harvested. We can suppose that irrigated maize has been cultivated only since the 1910's.

Wheat cultivation on *khet* was introduced in different periods depending on location and altitude. In Kathmandu, missionaries introduced wheat in the beginning of the 18th century (Fillipi, 1995). According to Bishop (1990), wheat has been grown on *khet* for a long time in Jumla.[9] The crop spread over all of central Nepal in the 20th century though

it arrived in some place quite late. For example Salme, a village in the middle mountains, first saw maize around 1980 (Ripert, 2000). In Aslewacaur, wheat cultivation on *khet* began around 1925. It is also mentioned in the 1934 conversion charts of the tax office of Gulmi (Regmi, 1978a). This reference could indicate that it was cultivated locally, but it could also simply be the reflection of the political will to encourage its cultivation. As a matter of fact, government incentives of the late 19th century did encourage the cultivation of wheat and barley in the winter after paddy was harvested. In 1866-67 incentives in Gulmi and Arghakhanchi districts were not successful because locally powerful individuals needed space for their livestock (Regmi, 1978b). The government was then unable to apply repressive measure such as banning cattle grazing on fields after rice was harvested. If winter wheat is to be cultivated on irrigated terraces, the practice of maintaining *goths* (winter animal stalls) on crop stubble must end. This and similar patterns are well-known to agronomists: an intensifying cropping patterns modifies herd management practices. Intensification has an impact on the sharing of common grazing land and is therefore, necessarily a collective exercise.

The intensification of cropping patterns is not specific to irrigated lands. In Darling near Aslewacaur slash-and-burn agriculture was practised until about 1910 for growing small-grain cereal (*kāuno*) and until about 1920, for growing maize (Lecomte-Tilouine *et al*., 2000). Agricultural succession in the upland fields in Pokhara, has been intensified since 1935 (Schroeder, 1985). In Darling, the process of intensification occurred around 1920: the biennial rotation of barley (*jau*), finger millet (*kodo*), and maize (*makai*) changed into an annual succession of two crops. Until 1920, barley was sown in August-September and harvested in April, after which time cattle grazed on the stubble. Finger millet was sown in May and harvested in November. Cattle were grazed on these fields until March. After this period of manuring (from November to March), maize was sown; it was reaped in July-August. This calendar of cultivation required that farmers cooperate in order to let cattle graze more or less freely. All had to saw barley the same time and planting a marginal crop such as mustard[10] was difficult then (Lecomte-Tilouine *et al*., 2000). Coarse plants with poor yields were intercropped with maize. Until the 1920's farmers in Aslewacaur, cultivated vetch (*gahat*), a plant related to finger millet (the white variety of *sāmā*); *ganauni* and plants still sown in the area such as maize,[11] black lentils (*māṣ*), finger millet, *kāuno* and rainfed paddy (*ghaiyā dhān*).

At the beginning of the 20th century the exploitation of the environment evolved in various parts of central Nepal (such as from Gulmi to Pokhara) (Lecomte-Tilouine *et al.,* 2000, Aubriot, 1997; Hitchcock, 1977; Schroeder, 1985). Some characteristics of 19th century agriculture (slash-and-burn cultivation and pasturing cattle) began to disappear. The cropping pattern intensified and, on irrigated land, the succession of several crops replaced the mono-cropping of monsoon rice. These transformations might, as the theory

of Boserup suggests (1965), have been a response to a demographic pressure (Lecomte-Tilouine *et al.,* 2000; Schroeder, 1985; Dobremez, 1986). Population growth coupled with an interruption in 19th century regional migration may have caused pressures resulting in the increase of village sizes and demographic density (Ramirez, 2000a).[12]

As the examples above demonstrate, in Nepal irrigation was not always associated with intensive cropping patterns. Before the 20th century, irrigation did not hold the role in intensifying farming systems that it holds today but in intensifying production by cultivating wet rice. Irrigation plays roles in agriculture intensification in Nepal: it allows wet rice production and increases the number of crops cultivated. Benjamin and Shivakoti (2002) do not distinguish between these two functions, and conclude that irrigation was not well developed in the 19th century because irrigation as a drive for agricultural intensification was not yet needed.

Instead of regarding—as Mahesh Chandra Regmi did—19th century Nepal as being sparsely populated and having a lot of uncultivated land, it would be better to assume that from the second half of the 19th century, the landscape began to become more saturated than it had been. The old farming system was characterised by pattern of extensive agriculture (Regmi, 1978b) compatible with the Bahun and Chetri expansion, who settled in central Nepal at the earliest during 16th century and extended to the east. This vast distribution required, on the one hand, mobility, and on the other, a large herd size (Ramirez, 2000a). After their movements stabilised, their population increased and there by generated pressure on the land. As a result, by the beginning of the 20th century extensive production system had become unsuitable and, in response, the farming system changed. Irrigation and the intensification of agriculture began. Intensification, in turn, made it possible to feed the increased population. This change may explain the demographic explosion that began in the 1930's.[13]

IMPLEMENTATION OF IRRIGATION NETWORKS

Irrigated rice cultivation: an imported technique

In the low and middle mountains of Nepal, the main purpose of irrigation is to supply water to wet rice fields. Both local population and the scientific community commonly attribute the introduction of irrigation to the mountains of Nepal to the ancestors of the Indo-Nepalis, originating from North India. Kathmandu Valley is an exception, in that here rice cultivation began in the 6th century, when the Licchavis ruled, (Khanal *et al*., 1988). Elsewhere in Nepal, rice cultivation is considered to be of Indian origin (Dollfus *et al*., 2003).[14]

Several elements allow us to associate Indo-Nepalis with wet rice cultivation. First of all, they have a rice-based culture i.e. rice is considered to be a noble product, a

culturally valuable foodstuff, as well as an element of classification of human groups and the environment. In fact, rice is the favourite food of both deities and humans. It is an acceptable offering in all its forms: roasted paddy, uncooked rice, cooked rice, flour, rice-based confections, etc.[15] As in other rice-growing countries, 'eating a meal' means eating rice (*bhāt khāne*)(Abé, 1995). The communal relations between castes also revolve around rice: since one cannot accept boiled rice prepared by a member of a lower caste, rice is an element of hierarchisation. It helps classify the environment, too: land terminology is based on the absence or presence of wet rice cultivation. The ancient categories of tax collectors also follow this dichotomy: the *jimwāl* was in charge of taxation on paddy fields while the *mukhiyā* collected other taxes. Other factors that associate the Indo-Nepali group with rice growing is the astonishing similarity of altitude in rice cultivation and settlements both occur only up to a height of 2000 metres.[16]

Some ethnologists' work contributes to reinforce the idea that Bahun and Chhetri introduced rice cultivation. Sagant (1976) demonstrates that the arrival of massive numbers of Indo-Nepali immigrants in this Eastern Nepal, for example, in the beginning of the 19th century disrupted the lifestyle of the Limbu. In valley bottoms, the Limbu implemented practices brought by the immigrants: they used the plough, transplanted rice and finger millet, and developed bovine rearing and captive breeding. The Limbu's own slash-and-burn agricultural practice gradually disappeared resulting in the uniform agrarian techniques that prevail today. The domination of the Indo-Nepali (paddy field cultivators) over population known as 'tribal' (livestock nearer and nomadic slash-and-burn agriculturists) is akin to a technical upset on virgin lands (*Ibid*).[17]

The historical reconstitution of development in Eastern Nepal set forth above may be applied to the entire country, and in particular, to western and central areas which have habitated by Indo-Nepali stock for a long time. According to Hamilton (1971), transplanted rice was the main crop in the 18th century in Palpa, for example. He does not mention any difference in practice according to the population group. It is then tempting to transpose to Central Nepal, with a few centuries' difference, Sagant's conclusions about the technical contributions of the Indo-Nepali group to Eastern Nepal. An analysis of the spatial organisation of the old Indo-Nepali kingdoms of Central Nepal shows that rice-growing areas acted as royal granaries, whose control seems to have played a crucial part in the construction of these mountain kingdoms (Ramirez, 2000b). Some factors force us to reconsider this picture of technical conquest by the Indo-Nepali as being too systematic to apply to the entire country. In Kathmandu Valley, for example wet rice was cultivated during the first millennium; some ethnic groups which lived along rivers cultivated wet rice using direct drilling and practising itinerant cultivation (Joshi, 1970). In low Kumaon in the Indian Himalaya west of Nepal, extensive rice growing using direct drilling coexisted with intensive cultivation based on transplantation in the beginning of

the 20th century (Pant, 1935). Clearly rice growing practices are more diverse than the model of domination suggests. We do not know if tribal groups cultivated rice before the arrival of the Khas. Terminology used today does not provide any insight. Tibeto-Burmese population (Tamang, Limbu, Magar) have their language for rice cultivation, but, like the Limbu, who uses Nepali terms, they might have developed it after borrowing the technique from the Indo-Nepali group, (Sagant, 1976). Indo-Nepalis use only Nepali terms, all of which have a clear Sanskrit root; if other populations were already practising rice cultivation, Indo-Nepalis migrants did not borrow terminology from them when they arrived. In sum, the introduction of wet rice the central Himalaya is more complex than has previously been assumed.[18] Nevertheless, the introduction of rice to a major part of the mountains of Nepal is associated with the arrival of Indo-Nepali migrants.

The artificialisation of the environment

Do studies of irrigation networks confirm that Indo-Nepali migrants introduced irrigation techniques? Unfortunately they do not; they do, however, highlight interesting elements for reflection. Irrigation networks in Nepal, likes those in the western Himalaya (Agarwal and Narain, 1997; Bon, 2000; Baker, 1997) are characterised by the diversion of water from a river or other source and its conveyance through earthen canals (*kulo*) by gravity. Creating a typology for such irrigation networks is difficult because several factors, including topographic and hydraulic consideration, which are not separate in a strict sense, have to be taken into account. Let us briefly reflect on some of the typologies other researchers have proposed.

Drawing upon the concept of 'technical lineage' defined by the French scholars of anthropology, Marzouk (1989) was the first to apply this concept to irrigation. This school of anthropology analyses technical processes in order to show their social dimension; its aim is to 'bring out the pertinent connections between a technical phenomena and a social reality' (Lemonnier, 1983, cited in Lemonnier, 2002). In this approach, a crucial theoretical concept is that of an 'operational chain' (*chaîne opératoire*), which consists of a series of operations used to transform a raw material into a manufactured product (Lemonnier, 2002). In irrigation, the raw material is the source of water, and the manufactured product is the water used by plants. Each operation in the chain corresponds to some operating principles and the coupled operation and operating principles constitute a technical lineage. In her study of African irrigation systems, Marzouk distinguishes three technical lineages:

- Water storage in the soil or on the surface. This approach corresponds to systems based on flood and low flow i.e. on the management of natural water movements;
- Systems related to mining investments. These use traction power and need preliminary installations, horizontal in the case of drainage galleries and vertical in the case of wells;

- The gravity systems are based on gravity principle and soil preparation.. Irrigated areas are organised by various land improvements. For these systems, the investment in land requires regular maintenance, transmissible in the form did work in the plot of land. In addition to the valorisation of agricultural work, it supposes the equality of kinship lineages as a specific social organisation. (Marzouk, 1989).

For generalisation, the above typology has to be amended. As a matter of fact, the principles of gravity and soil preparation are not specific to systems defined as gravity-dependent. Irrigation systems with drainage galleries, for example, could fit this definition when an investment in mining has been made. Moreover, since a social organisation cannot be connected to a hydraulic operating process; the exclusive association of the criterion of lineage organisation with gravity-dependent systems consequently appears too restrictive. It then becomes necessary to confine typology to the characteristics of the water source tapped and the mobilisation technology used. This is what Vincent (1995) did in her comparative study of irrigation systems in mountain regions. She identifies eight basic types of system off-take, underground canal, spread, collection systems in small cisterns, storage behind a dam, lift, combination and wetland systems.

Himalayan irrigation systems usually belong to one of the types proposed by Marzouk and Vincent (gravity and off-take systems respectively). The concept of technical lineage is interesting to use because it helps in the consideration of evolution from technical to another type of control. Indeed, a technical lineage should not be regarded as a fixed and rigid category. Labbal (2001) has shown that although irrigation networks in the high Indus valleys in Ladakh seem to be torrent diversions, their structural configuration—round plots of land and undulate canals—reveals that they are the vestige of managing floods related to the melting of glaciers. The construction of fields is linked to the movements of floodwaters and torrents, which are gradually channelled. The present system is a result of the evolution in technical control; it integrates the characteristics of a new technical lineage with those of pre-existing elements.

In the low and middle mountains of Nepal, rice-growing irrigation systems consist of rectilinear canals and land configuration is also rectilinear. The physical structures form a square. Both the hydraulics and land installations follow the logic of artificial construction based on a preset geometry. The systems are very different from those to high mountain systems whose architecture follows hydraulic movements related to floods and the changing course of rivers. This artificialisation allows for a certain abstraction of the relief and the environment. Such systems can exist both on plains and in mountains, a fact which complicates the study of irrigation systems considered from the point of view of the anthropology of techniques.

Farmer construction; royal or state incentives

We have suggested that the ancestors of Indo-Nepalis built paddy fields and designed irrigation networks. Yoder was one of the first researchers to stress the capacity of local farmers to build irrigation systems and to organise themselves in order to maintain them. He argued that the government began playing an important role in irrigation development only recently (Pradhan and Yoder, 1990). Regmi (1971, 1978a and b) disagrees. He points to farmers' inability or lack of will to finance the development of irrigation networks. He suggests that lack of capacity and finances explain the minimal development of irrigation in the 19th century, when only rich and influential farmers succeeded in mobilising enough community members to generate the collective organisation and effort required to develop canals (Regmi, 1978b). Each researcher bases his argument on a distinct source: Yoder argues from field observations and local stories, while Regmi based his analysis on archives. Texts dated before the 19th century are rare and do not enable a researcher to specify the concrete role of kings in irrigation development. What Regmi did was to compare these texts with those left by the kings of Kathmandu Valley, which show quite different interests regarding irrigation.[19] He concludes that irrigation did not play an important role in Gorkha or other mountain kingdoms (Regmi, 1971). It appears, though, that Regmi was rather hasty in linking the importance of irrigation to the amount of attention devoted to them by kings as royal attention does predicts neither the type of agriculture practised nor its development.

Because of the scarcity of historical documents,[20] I used oral histories to study irrigation systems in Gulmi and to consider different implementations which depended on the type of paddy field. Thus, fields with easy access to water, whether located on riverbanks, valley or slopes may have been built by farmers themselves, perhaps initially by indo-Nepali immigrants, using collective actions. The long canals that feed old paddy fields in contrast seem to be royal initiatives implemented during the reign of *bhure rājā*. According to one *jimwāl* (collector of taxes on paddy fields) in Aslewagaun, the old canals of the hamlet which supply some 'paddy fields on slopes' was constructed by *bhure rājā* without the collective action of the farmers. Similarly, an old person from Ridi, claimed that the irrigation canals, which supply the *ṭār khet* of the villages Birwa and Buwa above Ridi were developed by *bhure rājā* and specialists from Magar, *Kumhal* (potters) and *Majhi* (river boatmen) communities conducted the construction . The old person mentioned that the work was not forced labour, in which case the entire population would have been involved. On the contrary, the specialists were remunerated 10 rupees per *murí* of paddy to be produced or were given the right to cultivate paddy during 10 years. This point is interesting because it is usually assumed that farmers themselves constructed irrigation networks and that their investment entitled them to have water rights.[21] Undoubtedly, farmers investment in the construction of such canals was meager, may be it was only financial: it seems there was no voluntary or corvee labour.

Even if these canals were built during the reign of *bhure rājās*, they are not called 'royal canals' (*rāj kulo*), as the one in Argeli of Palpa District is (see Figure 1). King Mukunda Sen, the first king of Palpa, who ruled from 1518 to 1553 (Ghimire, 1990), is said to have taken the initiative to build the Argeli canal to support Rishikesh temple of Ridi with the tax collected from the paddy fields irrigated by the canal. Some *ṭār khet* are, in fact, still under *guṭhi* land tenure and farmers who cultivate them pay tax to the *guthi*. Documents show that the canal existed in 1787 (Pradhan, 1990).

For paddy fields located on high terraces or slope terraces, which were difficult to construct, Regmi's (1978b) remarks are justified: only rich and influential farmers were able to mobilise labourers. Even if specialists on the kings' initiative built the canals it does not preclude the possibility that users themselves managed them. We do not, however, know anything of King Sen's role in shaping the rules of management.

Unification marked another era in the development of irrigation in Nepal. The introduction, in the 19th century, of the Nepali State put an end to the rule of *bhure rājā*

FIGURE 1
STUDY AREA MAP

over Gulmi and provided incentives for constructing irrigation canals. Because the new State needed to increase its coffers in order to pay its civil servants, the governing Gorkhali chiefs promoted irrigation which brought in additional income (Regmi, 1978b). All historical texts show that during this era the State encouraged the development of irrigation. Prithvi Narayan Shah, for example, ordered the construction of irrigation canals and cultivation of fields, even if houses had to be moved (Regmi, 1971). Many other texts refer to serving land by building canals and to the maintenance of those canals.[22] At the beginning of the 19th century, leaders used forced labour to construct and maintain canals whose repairs could not be carried out only by the users.[23]

Policies, which supported the construction of canals and the utilisation of land, continued during the Rana government. The Mulki Ain of 1854 gave priority to irrigation: there was to be no obstacle to the construction of canals and the creation of irrigated lands (Regmi, 1978a; Pradhan 1990). This code recognised the existence of customary rules for sharing water and specified that the tax collector had to play an important role as an intermediary between governmental offices and farmers.

The State thus encouraged farmers to build irrigation canals and to be mobilised to repair canal networks. Regmi (1978a) does not believe that such incentives had much of an impact, as the increase in irrigated acreage was low during the 19th century. Pradhan (1990), in contrast suggests that the State held an important place in the 19th and the beginning of the 20th century. He believes it played the part of a mediator in developing irrigation: the State shaped property rights and used coerced and unpaid labour to build and repair irrigation systems.

A third period can be also discerned:[24] during the 20th century, the number of irrigation canals increased substantially. In Gulmi, all newly-built networks supply water to paddy fields either on high alluvial terrace (*ṭār khet*) or on slopes (*pākho khet*). *Agri* (the caste of former miners) dug canals of several kilometres.[25] In the hamlet of Dabung Khani, Ghinapatti—a blacksmith (*Kami*) who was 89 years old in 1992, said that he, his fellow caste members and their ancestors had built canals (figure 1) in many locations. Table 1 lists such canals as well their locations and dates of completion.

My field investigations confirmed that all types of paddy fields have existed since the 20th century but that each type has a different history. Canal networks established in valley bottoms or close to sources have an easy access to water and their canals are short. They irrigate paddy fields on banks of a river, in valleys and slopes and were built by farmers belonging to the stock of Indo-Nepali migrants who settled in the area in the 16th century. In these places access to water is easy, so the canals used to irrigate paddy fields on river banks, in valleys and slopes are short. Paddy fields served by long canals were built during the reign of *bhure rājās* on royal order. Later, farmers themselves built paddy fields on high alluvial terraces and slopes in the 19th and 20th centuries.

TABLE 1
DATES OF CONSTRUCTION OF CANALS[26]

District	Village	Name of canal	Completion Date
Gulmi	Harmicaur	Budho Kulo	1850*
	Pandi	Pandi	Second half of 19th Centure*
			1896*
	Aslewacaur	Tallo Kulo	1934
	Arbeni	Younger canals	1918 and 1934
	Macakot	Canal of Macakot	1945
	Chehemi		1953
Palpa	Cherlung		1927
Parbat	Pang Kanacaur, Paya		1943
	Puram		1966
Syangia	Jimtar		1915
Tanahu	Keladighat		1946

Canal of Aslewacaur: an untimely construction

The six-kilometre-long main canal of Aslewacaur along hillsides was built between 1893 and 1896 on a initiative of a villager named Tilochan Pandey.[27] Its construction took place during a turning point in Nepal's agriculture history but prior to cropping intensification on paddy fields. The irrigation of the 35 hectares of high alluvial terrace (*ṭār*) of Aslewacaur transformed rain-fed fields (*bāri*) into paddy fields (*khet*). Thus, at the end of the 19th century, the cropping pattern changed from maize, finger millet, and lentils to either a rice mono-cropping system or rice followed by mustard and buckwheat cultivation. In this area, irrigated maize was probably cultivated in the paddy fields only around 1910, and wheat was introduced much later. The transformation of *bāri* into *khet* at the end of the 19th century thus did not result in the intensification of agriculture in the sense of an increase in the varity of crops cultivated. It is likely that wet rice cultivation put an end to the cultivation of maize, which by then had become the main crop in the mountains. The canal transformed *bāri* into *khet*, but in the process made agriculture more risky because it was dependent on a weak canal, liable to be damaged by landslides.

The absence of villagers' mobilisation for 18 years provides two lessons.[28] First, the canal did not inculcate a response to improve agriculture production even though a certain pressure on land was already being felt. Second, the villagers were not ready to invest their time in the frequent and high level of maintenance the canal demanded even though it could provide them with the benefit of being able to grow rice. The building of the canal of Aslewacaur appears to be untimely and one can surmise that neither economic reasons, nor incentives or the intensification of the cropping succession, led to its construction. Some socio-economic and symbolic aspects may have influenced the

construction. By transforming the un-irrigated *bāri* into irrigated *khet*, the initiator of the canal could acquire the status of a tax collector, and thereby become a repository of local power. He would thus acquire, in the event of a success, prestige, privilege and social status. Moreover, the construction of a canal for the benefit of the community is considered a benevolent act. Undertaking such a meritorious act would help the builder's family move into the local circle of power-holding elite. These social incentives could also have motivated the Tilochan Pandey to initiate the construction of the canal.

The canal was rehabilitated in 1914, after which time the intensification of the cropping succession on paddy fields became possible. In the *khet* of Aslewacaur maize was already being cultivated in 1918. After the canal was repaired, the cropping pattern in *khet* was rice in the monsoon followed by mustard, then buckwheat and finally maize in the spring. With three crops being grown every year the canal became economically viable. Moreover, Tilochan Pandey also took advantage of the government's policy to build canals and managed to coerce or cajole the villagers to take part in its repair. It is said that he visited Kathmandu seeking an audience with prime minister Chandra Shamsher, who gave him a document ordering all villagers to help him. A farmer who refused to give Tilochan assistance had to give a part of his land, equal in value to the expense of carrying out the labour. When he returned to Gulmi from Kathmandu, villagers agreed to repair the canal. Tilochan Pandey sold individual water rights to finance the repairs, which were mostly done by the *Agri*. Today, the rice-growers who use the 35-hectare system are proud of their system and of their capacity to manage it.

Though they insist that the system was developed indigenously, its eventual construction involved the threat of an external authority and the possibility of punitive action. However, farmer's' participation was based only on financial investment not collective actions. It can thus be surmised that Tilochan Pandey knew of the various state policies that he might have taken advantage of to build the canal. It is difficult, however, to generalise and argue that similar individual tactics or state policies led, in the 19th century, to the construction of canals all over Nepal.

INDIVIDUALISATION OF RESOURCES MANAGEMENT

From a communal to an individual space

Until the beginning of the 20th century, the cattle of Gulmi were allowed to graze freely on irrigated terraces and grasslands (*kharbāri*) from *Maṅsir* to *Baisākh* (November to April). Grassland was managed collectively by lineages (*kul*). The villagers of Aslewacaur explain that 'strips of land' which started from the houses of a particular lineage group and extended to the limits of the village were parcelled out as the pasturelands. For Gaborieau (1978),

this type of management of territory by lineage is one characteristics of Nepalis' with the traditional relationship with land. The use of common lands (wasteland, forest, pasture, springs and access ways) was undivided and their management, which involved justice and policing, was formerly in the hands of the elders of different lineages branches. Individual property was not yet recognised at the central level and tax was levied at the community scale. In the beginning of the 20th century, however, local use began to acknowledge individual ownership and partition of grassland for cutting grass during the monsoon.

According to statements made by Aslewacaur villagers, land was recorded and individual appropriation recognised towards the end of the 1920s. Thus, at the same time, cattle were deprived of both rice stubble (because of the new cropping pattern of three crops per year) and open grazing on the grassland (because of individualised strips). Cattle had to be fed differently: they were permanently penned in cowsheds close to houses and fed fodder there. This is the present practice. This approach to feeding cattle is characteristic of settlements at the bottom of mountains in Gulmi, where farmers have little access to grassland (Michaud, 1993). Herd management thus evolved into a time consuming practice: farmers have to cut grass or fodder (a work requiring one to two hours twice a day) as well as to carry manure to the fields. Agricultural intensification increased the productivity of land per unit area, but reduced the average productivity of work.

This individualisation of space management can be observed in the hamlets of Gulmi, like Aslewacaur, which are located at the bottom of mountain slopes. It can also be observed in hamlets located at altitudes close to public pastures, such as Darling (Lecomte-Tilouine *et al*., 2000), where together with changing access to grassland and suppressing biennial crop rotation modified herd management. The practice was biennial rotation which involved dividing a slope vertically in two altering the crop from one year to the next, and grazing cattle on the stubble before sowing barley. Cattle management was collective, and the village chief (*mukhiyā*) decided where and when to graze the village cattle. The intensification of agricultural succession led to the end of communal approach to space management. Land was regrouped for exploitation; with the individualisation and atomisation of space, each family uses less land, and the total area of open grassland decreased.

Individualisation of water distribution

Side by side with agrarian intensification and the atomisation of space management, water distribution methods also evolved. Change can be observed in the irrigation networks built in the 20th century. Understanding the process necessitates comparing of various methods of water distribution.

Specific typology

In order to describe Nepal's diversity accurately and to shed light on the evolution in water management I chose my own criteria for comparison and developed a grid-based analysis

of water distribution systems in Aslewacaur area. Water distribution requires technical management by as well as a social organisation of irrigators. A complete typology of water distribution methods must integrate organisational, territorial and technical aspects and demonstrate awareness that any organisation is a reflection of its social context and that some technical elements emerge from organisational aspects.[29] As stressed in Lemonnier's (2003) contributions, "as soon as we consider that techniques are not something to which some meaning is simply added, but a complex phenomenon in which wide symbolic considerations are involved from the start, it becomes tricky to separate the 'technical' from the 'social' (or rather 'social-other-than-technical').

The grid I propose combines the organisational and geographical aspects of water distribution using the concept of 'irrigated sections' which I define as a group of plots that are irrigated by applying the same principles and that share common characteristics of water management. These sections are not systematic blocks as plots of land are not necessary contiguous. They also take into account how water is shared among sections.[30] Thus, I distinguish between a water division without any particular rule (other than collective consensus) and a division in which irrigation sections are defined. These sections can receive water either alternatively, on a rotational basis by 'water turns,' or continuously, by dividing the flow. Sharing water can be approximate or precise in which case an irrigation weir divides water in known proportions (see the subsequent sections on techniques of water division). Within a section, various distribution organisations can be found: in same system it is the first to arrive who uses the water first, while in others, there is a fixed schedule for watering. When a rotational system is chosen, it can be fixed or flexible, based on geographical criteria or on other criteria such as individual or lineage property.

To facilitate the comparison, I prepared schematisation of water distribution methods. Let us look at an example of four irrigation networks (figure 2). In Macakot and Chehemi the sections are irrigated by turn. The flow in the main canal of Aslewacaur (120 l/s) suffices to supply three secondary canals on a permanent basis. From each secondary canal, four sections receive water in succession. Here, there is a combination of flow division (among secondary canals) and time divisions. In the 'old paddy fields' of Aslewacaur, however, another system prevails. Here, sections simultaneously receive water at a low flow of 12 l/s. Irrigation sluices are used to constantly supply the sections with an equivalent share. Figure 3 represents these three types. In order to simplify the schematisation, the order of water distribution within a section (upstream-downstream, downstream-upstream or any other combination) has not been specified. Nor is it mentioned if the sections are contiguous or not, or if the section is determined by social criteria (lineage, clan, etc.) or by geography.

Techniques of water division

Water sharing can be based on a division of flow, on a share in the duration of irrigation or on the storage of a given volume of water. To divide flow precisely, farmers in Aslewacaur

FIGURE 2
WATER DISTRIBUTION IN THE SYSTEMS (ASLEWACAUR, MACAKOT AND CHEHEMI)

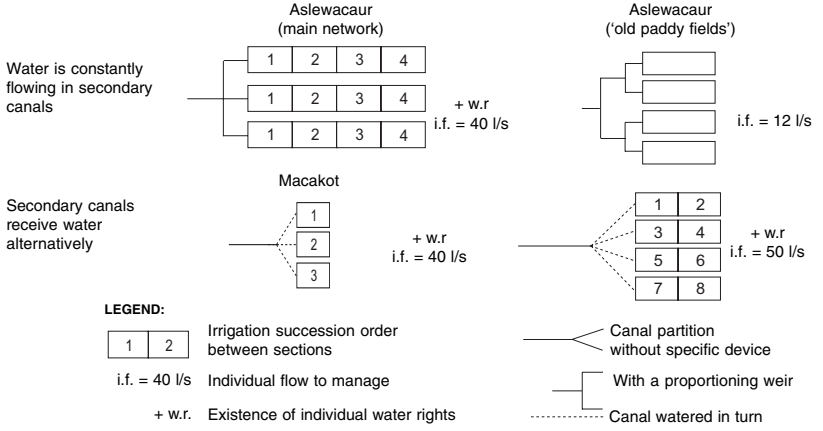
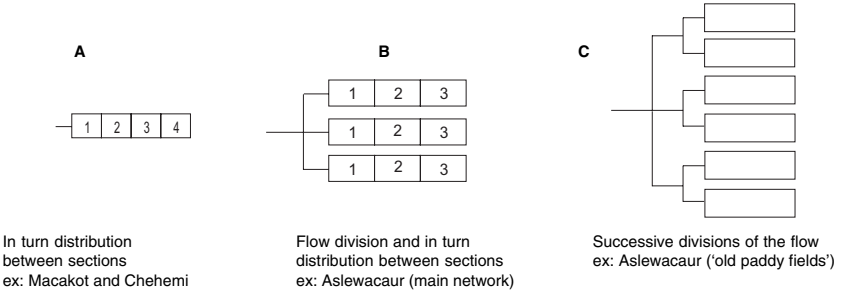


FIGURE 3
THREE TYPES OF SCHEMATISATION OF WATER DISTRIBUTION METHODS (ASLEWACAUR, MACHAKOT AND CHEHEMI)



use a proportioning weir, a tree trunk with rectangular notches carried out into it, which is placed in the canal perpendicular to the direction of flow. This sluice, which Ambler (1990) calls a 'partially proportionate' system of water division, separates secondary canals. It shares water with a precise measure up to even tertiary canals but not including the field level (which would constitute a fully proportionate system). The width of any given notch is calibrated according to water shares and governs the proportion of water to be delivered. In Sankar irrigation system of Syangja District, several proportioning weirs are placed in each canal in order to deliver to each farmer a flow proportionate to his share (Parajuli,

1999). The weir is called a '*sa̐co*' (literally 'key') in Aslewacaur and in Argeli, as well as in Surkhet region in West Nepal (Pinhorn, 1988). It is named '*gahak*' in Cherlung; '*dhārā*' (literally 'fountain') in Harmicaur and in the Julphe system in the Tarai, which was set up by migrants from Palpa and Pyuthan districts (Parajuli, 1999); '*gav*' ('the heart of a tree trunk') in Parbat District (*Ibid*) and '*khat bunda*'[31] in other irrigation networks in western Nepal (Pradhan (1989), quoting Martin and Yoder, 1987).

I discovered that this water division device is unknown in networks located in the western part of Gulmi. The device is found only in networks close to the Kali Gandaki River and is used to define flow proportions. An exception is the network of Maadi phā̐ṭ, a rice-growing area in the valley downstream of Tansen, Palpa District, where proportioning weir used to be placed to measure the flow of the canal. The height of water flowing through the notches is measured with finger as the width of the notch. The quantity of water delivered by the weir was expressed as follows: 'in a 8-inch broad notch, there are four inches of water' ('8 *aulko sa̐co mā, 4 aul pāni cha*'). Irrigation of each section of the network was determined on this basis.[32]

If the arrangement for dividing water is based on time, then the order of succession needs to be defined. Conversely, if the duration of irrigation is fixed, a time schedule should be set. The period of water delivery and the changing of turns among sections often occur at twilight ('when one can see the hairs of the fore-arms') or at mid-day, when sun reaches its zenith. In sections where water allocation was based on time, surprisingly precise techniques were once used even though such precision was not required from an environmental point of view (see, Aubriot *et al.*, 2000). For example, in Aslewacaur, Macakot and Chehemi (refer to figure 4) a water clock was used; in Maadi phā̐ṭ (in the system where an irrigation sluice was used to measure the flow), a stick was used as gnomon and its shade was measured in cubit (*hāt*) or span (*bittā*) in order to mark time. Nowadays, a clock is used.

When flow is low, storing water over night in a tank ensures that there will be a predictable flow in the day. In addition to the benefit of being able to irrigate during the daytime, this technique limits water losses due to seepage and evaporation during transport. The reservoir is a tool used to share the water delivered to various irrigation sections. It is a recent introduction to Gulmi; farmers say that the oldest one, which is in Kotakot, was established in the beginning of the 20th century.

Comparison of distribution methods

I applied my water division schematisation to the distribution methods I observed in Aslewacaur. These methods are defined in the literature[33] and are based on my observations of about thirty canal networks along the Barigad River, in the north-west of Gulmi District and along the Kali Gandaki from Arbeni to Cherlung (figure 1). Figure 4 synthesises the results.

In order to identify distribution methods that existed before transformation of the farming system I have distinguished between old networks and those built during the 20th century.

From the figure 4, one can deduce that all the networks, which were built during the 20th century are characterised by regulated management: there is no free flow distribution inside any irrigation section and individual water rights are defined systematically. Although the existence of individual water rights is not specific to recent networks (for example, old systems in Argeli use it), this evolution is consistent with the changes in the farming system discussed earlier, in particular with the individualisation and atomisation of space management.

The individualisation of water division has had repercussions for the physical structure of networks: distributory canals are designed so that each paddy field has direct access to a canal and water does not need to flow from field to field. This remarkable configuration reflects a preoccupation with giving relative independence to each beneficiary; no farmer has to wait until the field located upstream of his own, which may belong to another farmer, is filled with water before he can irrigate his own plot. Obviously, though, supply of the water is dependent on the presence of water in the canal, and thus on the presence of upstream beneficiaries.

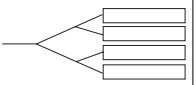
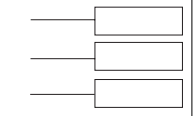
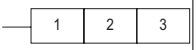
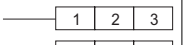
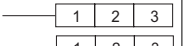
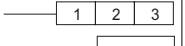
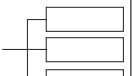
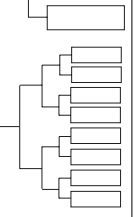
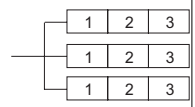
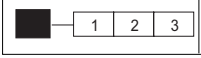
Just because a water distribution method is old does not mean it is simple. One of the oldest irrigation networks the *rāj kulo* in Argeli, has a system of water rights and divides flow up to the field level. Nothing proves that the current system of distribution has existed in this network since it was built. But according to Yoder (1987), the collective memory has no recollection of when this system began to be implemented. Thus, it can be supposed that the system is sufficiently old to have existed at the end of the 19th century. The arrangement in Argeli may have been used as a model for the networks of Aslewacaur or Cherlung since they also use water clocks to measure the duration of irrigation.

The comparison of irrigation systems in Gulmi District highlights the impact of the individualisation of resource management observed in the beginning of the 20th century on water distribution. As the discussion shows, the context of individual management did not prevent the construction of canal networks, which used collective methods. In fact, the individualisation of management relates to allocation and not to the construction of networks or to their maintenance tasks that are necessarily collective given the nature of access to water in the mountains of Nepal. [34]

CONCLUSION

In the beginning of the 20th century the farming system in the mountainous regions of Central Nepal experienced a transformation from collective management approach to a individualistic and atomised resource management approach. Irrigation underwent a similar change. Community pastures were closed, land was individually appropriated and

FIGURE 4
WATER DISTRIBUTION METHODS OBSERVED IN CENTRAL NEPAL

Type of water distribution	Irrigation networks built before 1900	Individual water rights	direct access to field	number of people irrigating at the same time	Networks built after 1900 (creation date in bracket)	Individual water rights	direct access to field	number of people irrigating at the same time
	Chorkate, Hulli *khola*			no				
	Santipur		no	no				
	Isma			no				
	Kaleni *khola*			no				
	*Cauresi phāṭ* (alternance day/night between up- and downstream)	sv.	no	no				
	Aruan, Juhang			no				
	Apcaur *tallo phāṭ*			no				
	Majuwa	1		no				
			no	no				
	Apcaur mini							
	Beltari	1	yes	yes				
	Sardewa [rights acc. to surface, expressed in hour]							
				yes	Macajit (1947) [clock, ' ']	1	yes	yes
	Biruwa			no	Chehemi (1995) [clock, 'cauthai']	1	yes	yes
	*Nisti phāṭ* (canals on both sides of the river share the water)							
		1	yes	yes	Saili *kulo* of Arbeni			
	Padi	1	yes	yes	(1918)	1	yes	no
	Jethi and maili kulo of Arbeni Apcaur			?				
								
	Hansara							
	purano *khet*, Aselwacaur			no	Cherlung (1928) [clock, '100Rs']	1		yes
	Harmicaur (may-be clock]			?	Phalebas (1930) [acc. invst, 'Rs']	1		yes
	Damka			no				
	Argali (*saco* till the field) :							
	Kanchi *kulo* [clock, '*muri*']			yes				
	Raj *kula* [clock, '*muri*']			yes				
					Aslewacaur (1914) [clock, 'ghari'] Kanchi			
		sv.	no	no	kulo of Arbeni (1963)	1	yes	yes
	Yadung, Gwadi	1	yes	yes	[watch, '*sajh*']	1	yes	yes
	Birgha [clock acc. to surface, '*mato-muri*']							
					Kotakot (~1900)- [clock+water turns around 1940]	1	yes	yes
					Rambari (reservoir : 1963)			
								no

Distribution between areas

1 | 2 Irrigation succession order between areas

Division of a canal without specific water division device

Reservoir

With a proportioning weir

sv. : Several

[,] Information about water rights: measurement type, unit used acc. invst: according to investment

?: Doubt about the quality of the information

no: No individual rights or direct access to field

yes: Existence of individual rights, of direct access

Distribution within an area

Free distribution

on rotational basis

individual water rights were defined for new canal networks. Because of the pressure on land, a process of cropping intensification occurred both on rain-fed fields and on irrigated terraces; irrigation supported a diversification of crops (away from just paddy or sugarcane). This process explains the demographic explosion that started around 1930 as well as the increase in the number of irrigation networks during the 20th century. In Gulmi and Palpa districts, local miners constructed long canals on hillsides. The main canal in Aslewacaur was first built before the cropping pattern on irrigated terraces was intensified. This fact partly explains villagers', refusal to take part in its development and calls into question the assumption that economic reasons alone account for its construction.

The above discussion on farmer-managed irrigation systems demonstrates the importance of taking into account the social, economic and political contexts in order to understand the history, implementation or distribution system of any network. It also underscores that these histories are still full of unanswered questions.

NOTES

[1] This paper encapsulates a part of my Ph.D. thesis (Aubriot, 1997), which has been summarised for publication (Aubriot, 2004). Figures 1 and 4 have been already published in French.

[2] Gulmi District is administratively in Western Nepal, but geographically in Central Nepal.

[3] Between the two geographical units of high mountains (*himal*) and the Chure, fall the 'middle hills' which include the low and middle mountains (Smadja, 2000).

[4] Irrigation is also practised in the high mountains, but the geographical and social environment is very different and it is vital for agriculture.

[5] In Kathmandu Valley, some rice fields depend upon systems that collect surface water. They do not have irrigation canals as such, but they do have some hydraulic installations. In the Tarai, since the soil is alluvial and the topography flat, wet rice can be cultivated on rain-fed land (Parajuli, 1999)

[6] My transcription of Nepali terms follows the system established by R.L. Turner (1990).

[7] Some of these fields may be irrigated, but they are still called *bāri* (Yoder, 1986; Pradhan, 1990) as wet rice is not cultivated.

[8] This information is surprising because it does not seem that the maize sown on *khet* is a different variety from that sown on *bāri*. In any case, it is not currently the case. The idea of sowing maize on *khet*, i.e. sowing it at a date before to the usual one, could be inspired by practices observed in India. Migration towards India took place in the middle of the 19th century. This assumption would explain the mention of Calcutta.

[9] It seems that wheat was mainly cropped on *bāri* in the beginning of the 19th century. In 1819 Hamilton (1971) noted that wheat was one of the main crop in Jumla Valley. He did not specify if it was cultivated on *khet* or on *bāri,* but as *khet* was limited, we can suppose that it was mainly non-irrigated cultivation.

[10] This plant is not mentioned in the list drawn up by Hamilton (1971) in the beginning of the 19th century.

[11] As opposed to what farmers' remarks could lead one to believe, maize is a relatively recent crop in Nepal. It was brought to India by the Portuguese and later arrived in Eastern Nepal. In the beginning of the 17th century it was rejected by the king of Kathmandu, because his astrologers had declared it would result in food scarcity (Hasrat, 1970). Nevertheless, it spread quickly in the mountains and according to Kirkpatrick (1969) had become the main crop at the end of the 18th century. It was not yet cultivated in Garhwal in 1809 (Regmi Research Series, 1971, Vol. 3. No. 7).

[12] Many ethnographers note that the migration to India at the end of the 19th century was a consequence of demographic growth and land saturation. Sagant (1978) disagrees with this assertion: these elements, he argues fostered increase the migratory movement but did not create it. The origin of these migrations lies, as the historian M.C. Regmi suggests, in the fact that the state regime dominated, exploited and otherwise made the life of Nepali rural population miserable. The poor thus began to flee the country in 1820.

[13] The national census shows this (the first one was conducted in 1911). As national demographic data can only be considered reliable from the census of 1952 (Gurung, 1989), one must rely on field investigations. The studies conducted by Ramirez (2000a) and by Lecomte and Michaud (2000) in Gulmi and by Bishop (1990) in Jumla confirm that there was a population explosion in this period.

[14] Several sources report that there is a myth about the introduction of rice from the Ganga plain in the south. The *bhāṣā vamśāvali* indicates that before the reign of Amsuvarma (605-621) inhabitants subsisted on fruits alone. Balabhadra may have introduced it (Paudel, 2020 VS). The most widespread myth is in the history of Matsyendranath reported by Vajracarya (2024 VS): when Gunakamadeva, the king of Bhaktapur (987-990) asked his subjects about their wishes, they answered they would like to cultivated paddy and requested the king to ask his son-in-law, the god Narayan in the form of a jackal, for some seed. Narayan, so the myth goes, explained how to cultivate rice and advised the king to dispatch some men to India.

[15] In Vedic literature, rice is mentioned in three senses: the existence of different varieties of rice, the use of various rice preparations as offerings in rituals, and the medicinal properties of rice (Kumar, 1988).

[16] A variety of red rice is, however, cultivated up to 2,800 metres in Jumla, Western Nepal.

[17] The clearing of these lands was supported by the central government (Sagant, 1976).

[18] As for rain-fed rice, we do not have enough historical information to put forward a hypothesis.

[19] The most well known mention of the kingdoms outside of Kathmandu is the directive of King Ram Shah of Gorkha (1603-1633). It is related to water management but not to the role of kings in the construction of networks. This directive specifies that the king did not want to manage disputes concerning the use of water, as the need for access to water is the same for all. The king claimed that he would not intervene in its regulation and would lets the villagers act according to their customs and needs (Hasrat, 1970). A 17th century inscription in Kathmandu Valley reveals, however, that royalty did play a role of irrigation in the egalitarian organisation specifying principles of access to water (Lévi, 1985, Vol 1). Moreover, during the Malla period, an equitable division of water was recommended to please goddess (Wright, 1972).

[20] In the area ground Palpa, some documents concerning a royal gift of land and a royal prohibition of destroying a canal were found. Three documents, written in 1514, 1752 and 1783, mention a gift of land (*birtā)* by the king of Palpa to a Bahun. The last stipulates clearly that the fields were *khet*. A letter dated 1795 and signed by Prithvi Pal Sen threatened to punish any person who destroyed a canal built by Chintamani Upadhyaya, a Bahun villager (Ghimire, 1990).

[21] Coward (1986, 1990) sheds light on the essential relationship in traditional irrigation systems between water rights and investment in the construction of an irrigation canal. In short, those who invested in the construction of a canal—and later their heirs—are acknowledged to be the 'owners of the water'. They are regarded as legitimate holders a share of water.

[22] Cf. *Regmi Research Series* : Vol. 9, No 11, 1977; Vol.13, No 4, 1981; Vol.13, No 10, 1981; Vol.14, No 12, 1982; Vol. 16, No 7, 1984; Vol. 18, No 6, 1986; Vol. 20, No 10, 1988; Vol.21, No 5, 1989.

[23] Regmi Research Series: vol. 14, No 12, 1982; vol. 16, No 7, 1984.

[24] Pradhan (1990), who bases his presentation of irrigation history on the political history of the country, identifies four periods, different from those presented here: before unification, after unification, the Rana period and the democratic period.

[25] Some iron and copper mines existed in near Gulmi and formed an entity entitled '22 mines' (*bāis khānī*) during Rana times. They were located in parts of several kingdoms corresponding to the current districts of Gulmi, Baglung, Myagdi, Parbat, Rukum and Mustang. Until they were closed in 1920 the mines were a second economic resource (in addition to agriculture) in the area. Hamilton noted their existence in 1819 and we can suggest that they were used twenty years before the reign of *bhure rājā*. Also supporting this point of view is the fact that the suffix *taksar* in the name of sites such as Wamitaksar and Baletaksar means that coins were struck there (Ramirez, 2000a). When the mines were opened, the Agri (the miners caste), Magar worked in with the Kami (blacksmith) in the following sequence: the Agri dug galleries, not very deeply and excavated the ore while the Kami, outside of the mine, fired the ore to separate the copper from the rock. The Kami also manufactured and repaired the tools.

[26] The dates with asterisks are those mentioned by the Kami, while those without asterisks are mentioned by the concerned villagers.

[27] Another version says it from 1902 to 1905.

[28] Another version suggests that it was nine years.

[29] See the examples of the social dimension of the irrigation described by Ambler (1990), Diemer and Huibers (1996).

[30] The point here is not to analyse organisational and institutional aspects. For that, see Pradhan (1989) and Lam (1998).

[31] It could be a *kāṭh banda* (a wooden closure) or more probably a *kāṭh baṇḍā* (a wooden irrigation sluice). The idea of an equitable share is communicated by the verb *bā̃ṛnu*, to divide).

[32] Today the proportioning weir is no longer used because flow is more important.

[33] Studies by R. Yoder, E Martin and U. Pradhan in Majuwa, Gulmi District; Phalebas, Syangja District; and especially Argali and Cherlung, Palpa District (Martin and Yoder, 1983; 1988; Yoder *et al*., 1987; Yoder, 1986; Pradhan, 1990). Texts found by the historian Ghimire (1990) on some networks in Palpa District.

[34] Individual diversions of river or spring water are extremely rare. Moreover, there is no mining of individual horizontal galleries that tap sub-surface flows (or underground canals in Vincent's (1995) typology as is the case in the French Cevennes in mountains for example (Salesse, 1993).

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WOMEN AND IRRIGATION IN NEPAL: CONTEXT, ISSUES AND PROSPECTS

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ABSTRACT

In spite of the prevailing gender norms, which favour men, some legislation passed by the Nepali government acknowledges the role of Nepali women as irrigators. Policies which increase and strengthen women's participation in the irrigation have been formulated. This article explores how these policies have been implemented and suggests measures which can be taken to further bolster women's participation in this sector.

BACKGROUND

In Nepal, farming typically is categorised as men's work. The reality, however, is that women do participate in subsistence agriculture. In fact, research by Acharya and Bennet (1981) reveals that Nepali women spend 9.91 hours per day on farm activities, while men spend only 5.86 hours.[1] Studies designed to explore women's roles in irrigation demonstrated that rural women carry out various irrigation-related activities, too. Zwarteveen *et al.* (1995) note that the female members of farms in the Rupendehi District's Chhatis Mauja irrigation systems that are jointly managed by men and women are involved in irrigated agriculture. According to Ghimire (1996), women living in the hills participate in irrigation management tasks only to the extent of providing labour. They play a marginal role in decision-making.[2]

Nepali agriculture, which is the main source of rural livelihood, is characterised by a poor resource base, fragmented landholdings, high population growth, and under-employment. Because it does not sustain rural population, males are forced to migrate to urban centres in search of work. Especially in the hilly region, it is men, not women, who are increasingly being drawn into the cash economy. When men leave home to supplement household incomes, women are left to shoulder the burden of both household and farm activities. The ongoing insurgency by the Maoists and the resultant insecurity has accelerated the trend.

In recent years, the Nepali government has acknowledged that women are irrigators and has formulated policies to promote their participation in irrigation. The

Irrigation Policy of 1992 states that the executive committees of water users associations (WUAs) formed for irrigation purposes should comprise at least 20 per cent women members. The Irrigation Regulations of 2000 mentions that at least two women should be included in the nine-member executive body of any WUA.[3] The recent Irrigation Policy of 2003 states that one-third of an eleven-member executive committee of a WUA should be women.[4] Whether or not these policies actually help Nepali women achieve equity depends on how the policies are implemented. This paper reviews how these policies are operationalised. It also attempts to understand the relevance of these policies by exploring what roles women actually play in irrigation. In addition, it reviews literature about women's role in irrigation and explores how women's issues have been conceptualised in various discourses on development.

INTRODUCTION

Nepali society perceives irrigation as men's work for two main gender related reasons. First, irrigation involves physically strenuous work, which it is assumed, women are incapable of doing. They should not, this argument goes, use *kodali* or *halo*. Second, irrigation activities take place outside the household domain which is where women are meant to confine their activities. The level of social interaction with outsiders, which irrigation necessitates, renders women's involvement inappropriate—or so this view holds. This stereotyping of women's sphere of activity both reflects the domination of men in economic, social and political arenas and, in turn, promotes that view of the social reality.

This dominant view of male superiority has, of course, been repeatedly challenged from as early as the 18th century.[5] From this critique, have emerged many different types of knowledge which try to understand how social realities, including those related to gender divisions, are constructed. Much sociological and anthropological research demonstrates that women experience most situations differently than men do. Women are placed in a less privileged position. In many cases, they are not only unequal but also oppressed, restrained, used and abused by men (Ritzer, 1996).

Women's experiences of differences, inequality, and oppression vary according to their social location. Consideration of women's perspective has given rise to a variety of theories of gender differences, inequality and oppression (Ritzer, 1996). A pioneering work concerning women was undertaken as early as the late nineteenth century by Frederick Engels. In *The Origins of the Family, Private Property and the State*, he seeks to explain women's unequal position and oppression. He argued that women's subordination results not from her biology but from the social arrangements, like the institution of the family, which a society legitimises.

GLOBAL CONCERNS AND THE DEVELOPMENT DISCOURSE ON WOMEN

In addition to political activists like Frederick Engels, global institutions such as the United Nations (UN) have also challenged the idea of male superiority. The Commission on the Status of Women was established in 1946 under the auspices of the UN as a subsidiary body of the Economic and Social Council. Its role was to create guidelines and formulate actions in order to improve the situation of women in the economic, political, social, cultural and educational fields. In the early 1950s, the UN called on governments to stop discriminating against women.

The 1970s gave birth to the concept of 'women in development' (WID), a term coined by the Women's Committee of the Washington D.C. chapter of the Society for International Development (SID). Before WID policies generally observed the reproductive roles of women rather than their roles in development: they were the focus of welfare programmes that dealt with nutritional education and home economics. The proponents of WID, in contrast, argued that by regarding women as passive beneficiaries with only a reproductive role to serve, women had been excluded from the development arena. Their marginalisation, in turn, led to a further deterioration in their status. WID emphasise instead that women's productive roles should not only be acknowledged but also be integrated into the national economy. This strategy it was argued, would improve the status of women. The WID's advocacy for social justice and equity was facilitated and strengthened by the UN when it declared that 1976-1985 was Women's Decade.

In its initial phases WID was influenced by liberal feminists movements in developed countries and by the emerging body of research on women in developing countries. During the 1960s, the feminist movement in North America and Western Europe, was primarily concerned with women's reproductive rights, equal rights for women and equity in employment. Much researches conducted in developing countries supported WID's dominant discourse of equity and economic efficiency. One influential work was *Women's Role in Economic Development* (1970), in which Easter Boserup examines the farming activities of women in Sub-Saharan and shows how policies that overlook women's contributions to agriculture have detrimental affects on women's income and status. Drawing upon the conclusion of Boserup's and other studies, WID advocates claimed that women's productive roles should be targeted. They argued that increasing women's productivity would result in the more efficient use of resources, which, in turn, and would have positive affect on national development. Providing women with technology and credit was regarded as the accepted means to increase their productivity.

The concept of WID came under attack by Marxist feminists, who argued that the problem was more of achieving equity for women than of integrating them. They argued that the super-structure of patriarchy, which crosses all social, economic, legal and political structures, is the main cause of women's subordination and demanded a structural

adjustment. They argued that unless the overall structure was transformed, providing women with technology and credit would not bring about the desired results. In response to their argument the term 'women and development' (WAD) replaced WID. WAD policies were based upon equity; emphasis was given to women's equal participation in development and to improving the conditions of women (Bhadra, 2001).

Since the late 1980s, the acronym 'gender and development' (GAD) has been gaining ground. One of the reasons for GAD's popularity is that it perceives the problem more holistically than WID or WAD. In particular, its policy recommendations address concerns that relate not just to women, but to men as well. Gender is a socio-cultural construct that varies across and often within. GAD focuses on the roles of both men and women because it is by analysing the differences between the roles and relationships of men and women that the discrepancies between men and women can be better understood. GAD focuses on both the productive and reproductive roles of women and tries to integrate men and women into the development process. Proponents of GAD argue that it fulfils the strategic needs of women by empowering them and improving their position in society.

The discourses on women and gender described above had a considerable effect in Nepal, as the section below examines more closely. It details how these dominant discourses have shaped Nepal's policies and programmes on women over the years.

WOMEN'S ISSUES IN NEPAL

The global development discourses on women have been reflected in the various policies and programmes of the government of Nepal. After Nepal participated in the International Women's Year and the First World Conference on Women in Mexico City in 1975, some changes, which favoured women, were made in the Civil Code (Muluki Ain). In particular, inheritance rights were granted to daughters if they remained unmarried up to the age of 35.

In the 1970s, women were targeted under the welfare programmes implemented by the Women Service Coordination Committee (WSCC), which was established under the aegis of the Social Service National Council (SSNCC). From the Sixth Five-Year Plan (1980-1985) onwards, conscious attempts were made to involve women in the development process. A separate WID chapter was included in the Sixth Five-Year Plan and the government's approach emphasised efficiency approach towards women. The Women Development Section was established at the Ministry of Panchayat and Local Development (MPLD) during this period. The Seventh Five-Year Plan (1985-1990) attempted to incorporate both a participatory and an efficient approach to involve women (Bhadra, 2001). The Eighth Plan (1992-1997) also expressed the government's commitment to ensuring the participation of women in the development process, and

WID units were established in various ministries.[6] The Ninth (1997-2002) and the Tenth (2003-2008) Plans have adopted many GAD policies and programmes including mainstreaming of gender equality and empowerment in different sectors. As was mentioned above, irrigation is one key sector in which steps have been taken to strengthen the roles of women.

Before delving into the roles and participation of women in irrigation, it is relevant to understand how scholars conceptualise irrigation as an enterprise as well as to review relevant literature on irrigation in Nepal.

IRRIGATION MANAGEMENT

Irrigation management includes both technical and organisational tasks. The technical activities are related with the physical infrastructure that captures, transports and distributes water. The organisational activity is the type of institution required to allocate and distribute water and to maintain the system. Organisation and technology must be compatible. An irrigation system is conceived within local physical and organisational boundaries: it is situation-specific (Horst, 1998). Walter Coward, one of the sociologists who sought to understand irrigation as a social process, argues that irrigation activity involves both social organisations and institutions that are fused together through roles (Coward, 1985).[7] In short, irrigation management is a socio-technical process including operation of physical infrastructures as well as human interactions.

Irrigation systems can be grouped according to their physical, operational and organisational types. Physically, canal systems can be in the form of closed conduits, elevated fumes and earthen lined or unlined canals. From the operational point of view, irrigation systems can be grouped according to the flow in the canal, that is, either intermittent or continuous. In terms of organisation, an irrigation system can be centralised or decentralised and managed by an agency, farmers or jointly. In terms of management of water, the system can be either major or minor (Horst, 1998).

Irrigation systems in Nepal are broadly grouped into farmer managed irrigation systems (FMIS) and agency managed irrigation systems (AMIS). FMIS, as the name implies, are systems that are built, managed and governed by the beneficiaries. For centuries Nepali farmers, by developing system specific norms, have organised and managed irrigation systems without interference from the state. It is reported that there are as many as 21,000 FMIS in Nepal, and while there is no complete inventory it is estimated that FMIS irrigate about 781,000 ha across the country (Dixit, 2002). FMIS irrigate anywhere from a few to about 21,000 ha. They are autonomous, self-governing and decentralised entities (Pradhan, 2003). AMIS, on the other hand, have a shorter history: they were launched by the state in an organised form only after 1951. They are designed to serve thousands of hectares

of cultivated land and to provide water to a large number of water users. The Department of Irrigation (DOI) under the Ministry of Water Resources manages AMIS. As of 2001 AMIS served about 335,100 ha of land throughout the country (Dixit, 2002).

In an AMIS, the concerned agency is responsible for the management of the system and farmers play a minimal role. Studies demonstrate that AMIS in spite of having large investments, are less effective and efficient than FMIS. To overcome the shortcomings of AMIS, the government, in 1980's initiated a policy of transferring the management of irrigation systems to farmers under a scheme known as the irrigation management transfer (IMT) programme. In IMT, the DOI initially works jointly with a WUA and later, when that WUA is capable turns the irrigation scheme over to the users[8]. A WUA is formed using the hydraulic boundaries of the system. Users are organised hierarchically, from the block and tertiary levels to the main system level. The second phase involves drawing up a joint agreement between the WUA and the DOI stating the roles and responsibilities of each. After this, steps are taken towards the institutional development of the WUA so that it become capable of managing the systems The final phase is when a scheme is turned over to its users (Sharma, 2004).

To make irrigation management more effective and efficient, the roles that user' who include both men and women farmers, play are crucial.

ROLES AND RESPONSIBILITIES OF WOMEN AND MEN IN IRRIGATION

As mentioned earlier the organisational aspects of irrigation management include processes such as acquiring, allocating and distributing water, maintaining structures, mobilising resources and resolving conflicts (Coward, 1984; Horst, 1998). The physical structures of an irrigation system as well as the norms, values, mores and customs of the society in which it is embedded affect the socio-technical process. The gender norms of a society affect the way women and men organise themselves to partake in irrigation activities. The section below examines how gender roles are reflected in the various processes of irrigation, it is based on a study of two FMIS in Nepal, one in the hills and the other in the Tarai.[9]

Water acquisition: This is the process of getting water from a source. Men participate more than women in this activity. The difficulties in reaching the headworks, which, especially in the hills, tend to be in inaccessible sites may be an important factor in limiting women's participation. If, however, labour is compulsory and a household lacks men or the cash to hire labourers, then women do get involved. Sometimes cash acts as an incentive for women's participation (Ghimire, 1996). While women may provide labour, they do not play any role in decision-making.

Water allocation: This means assigning rights to users and determining who shall have how much water (Uprety, 1989). According to Horst (1998), water allocation to tertiary units can be either supply or demand-driven. Supply-driven allocation is based on the equitable division of water available at the source over the sub-areas of the scheme. In demand-driven allocation, in contrast water is allocated at the source and distributed according to actual or estimated requirements of crop. The two systems studied practice supply-driven allocation and the rules and procedures of the WUAs govern allocation. Usually it is the executive committee of a WUA that lays down the rules for water allocations at all levels, from the main branch to the secondary and even tertiary levels. Despite the formal rules in both systems, in practice large landowners, in all cases male, had more access to irrigation water.

Water distribution: Distribution is the actual delivery of water to farm plots. Parajuli (2001) identifies two types in FMIS: downstream and upstream control. Downstream control is demand-based, while upstream control is supply-based. Both women and men are involved but men are more involved at the main branch whereas the women are involved in distributing water at the branch and field channel levels (Ghimire, 1996). If an irrigation canal passes near their homesteads, then women of all groups, irrespective of class, ethnicity, class, household size and structure, distribute worker. In some hill communities, women form small women's groups to carry on night time irrigation. The distance between a household's fields and the canal is an important factor determining women's participation in only this activity: women whose fields are closer to their houses (and therefore the canal) participate. If the distance is great, the inconvenience and the risk in leaving their children and walking long distances precludes their participation.[10]

System maintenance: It is the repairing and cleaning of canals and other appurtenances in order to ensure the regular, efficient acquisition and allocation of water. It includes regular emergency works. A user's participation in regular maintenance establishes and confirms his/her household's rights to water.[11] Both men and women participate. Women, whose households have no men and cannot afford to hire labourers, provide their own labour. Most women are reluctant to work on either main or branch canals of large irrigation systems but are involved in the maintenance of tertiary canals. Women often take meals to working labourers.[12]

Resource mobilisation: Resource mobilisation is an important process because it is only through effective mobilisation of cash and labour that an irrigation system can develop and be sustained for a long time (Uprety, 1989). Women of lower income groups are usually the people that provide labour. If construction is paid, sometimes women provide labour

for more days than men. Cash acts as an incentive for their participation (Ghimire, 1996). The fact that more women are involved does not imply that they can take decisions regarding resource mobilisation. Instead, is the executive committee of both formal and informal WUAs that decides what resources to mobilise and how.

Conflict management: Disputes and conflicts among the farmers are common. Inadequate and unequal amounts of water and nocturnal stealing of water are some of the main causes that give rise to ill feeling. If there is a WUA, then the guilty are punished according to its rules (Uprety, 1989; Ghimire, 1996).

WOMEN'S PARTICIPATION IN WUAs

While both men and women are involved in irrigation processes, the levels and types of their participation vary according to gender. Men both contribute labour and make decisions while women provide labour but rarely are involved in decision-making. A WUA executive committee is the top decision-making body, so only with women's active involvement in this forum, can they safeguard their interests regarding irrigation management.

The Nepali government, through the ratification of specific legislation, has acknowledged that Nepali women are engaged in irrigation and related works. For instance, the Irrigation Policy of 1992 states that at least 20 per cent of the members in the executive body of a WUA should be woman. The Irrigation Regulations of 2000 stipulated that there should be two women in the nine-member managing committee of the WUA. The Irrigation Policy of 2003 mentions that one third of every executive body should be woman. Since these legislative changes women's participation in WUAs has indeed increased. Koppen *et al*. (2001) in their study of Nepal West Gandak Irrigation System, noted the women irrigators were appointed in different tiers of the WUA. They note that with the greater involvement of women, WUA meetings have become more orderly.[13] According to Udas (2001), since the Irrigation Policy of 2000 was ratified women's participation in the managing committees of WUA has increased.

In general, the heads of households who have land in the command area become WUA members. As a result, only those women who have land registered in their names become WUA members. Being a member, however, does not guarantee that a woman will get to participate in the proceedings of the WUA managing committee. For instance, an elderly widow might have land registered in her names but since it is her adult son who carries out all agricultural activities, it is they who represent their mothers. In addition, legal documents may identify women as landowners solely so that their husbands/fathers/father-in-laws/brothers can circumvent land ceilings and escape land taxation. This pattern was frequently observed in the Tarai irrigation scheme studied.

Land-owing women automatically become general members of a WUA but usually are not interested in participating in the WUA's proceedings. Some might not even know that they are general members. On the other hand, young widows, separated wives, de facto women heads whose male family members have migrated are actually involved in irrigation and related works but often do not hold the land they manage in their names; in consequence, they cannot be members of a WUA. Similarly, male tenants who cultivate lands of absentee landlords conduct all irrigation activities but have no say in WUAs. The landlords, in contrast, are WUA members though they may attend their farms only to collect agricultural rents.

Women's participation in irrigation works will continue to increase as more men migrate to urban areas in search of jobs. But not all women are equally involved in irrigation. Women irrigators are usually from the poor nuclear families, whose male members have migrated in search of other income-generating avenues or are separated, widowed with young children (Ghimire, 1996; Dawadi, 1999). They are mostly young and married and have little or no education. It is they, not women in general, need to be empowered in decision-making processes by involving them in WUC. One of the most glaring shortcomings of the irrigation policies of 1992, 2000 and 2003 is that women's participation in WUA, is these have all been indifferent to the internal differences between different groups of women. Though these policies continue to emphasise women's participation in WUA, they do not sub-categorise the group of women which needs to be involved and empowered.

Women who qualify for leadership positions in WUA come from well-off households and have the time to pursue community activities. Because they are not tied to domestic chores, they can travel to the district headquarters when required. It goes without saying that they are educated and can communicate effectively with outsiders (Sharma, 2001). Studies show that it is those who can speak the language of development —a skill acquired by high educational attainment or prior involvement in government offices or student politics at the school or college level—who usually occupy such positions (*Ibid*). Until more women become capable, ensuring that women are represented in WUA is simply token representation, which brings in men (namely, their husbands) by proxy.

Men in WUA generally do not communicate information about agendas and proceedings to women members. Because they are not fully informed of the events that have transpired, women do not feel inclined to attend the general meetings of the WUA; when they do attend, women usually hesitate to speak about their needs and problems. Women usually assume that they have to be educated and eloquent to share their opinions at such large gatherings (Ghimire, 1996; Beckmann and Beckmann, 2000; Dawadi, 1999; Udas, 2002).

Under the pretext of involving women using a quota system, educated, high class women are selected. This category of women, because they are educated, vocal, rich and leisured might not, in fact represent the needs of the actual women irrigators.

Studies have shown that the participation of women in WUA is related to their rights to irrigation water. In general, women have better water use and decision-making rights in AMIS than in FMIS because AMIS, which are subject to the donor pressures, national policies, and project regulations, make provisions for women's inclusion in WUA and the WUC (Pradhan and Meinzen-Dick, 2003).

IRRIGATION POLICIES AND DEVELOPMENT DISCOURSE

Global development discourses about women have influenced the policies of the Nepali government which deal with irrigation in general and with women's role in irrigation in particular. This influence can be detected, for instance, in the irrigation policy of 1992, 2000, and 2003. Nepal's Eight Plan (1992-1997) announced its commitment to incorporating women's participation in the development process. This declaration was followed by establishing WID units in various ministries. Nepal also participated in the Fourth World Conference of Women in Beijing (1995) after which the Ministry of Women was established and discourse focusing on gender equality and women's empowerment began to gain ground. In 1996, the Ministry of Women formulated the 'Gender Equality and the Empowerment of Women: National Plan of Action' (NPA) to operationalise the Beijing Platform for Action (Bhadra, 2001). Taking the same discourse into consideration, the Ninth Plan (1997-2002), encourages women's participation in irrigation by stipulating the degree of their involvement in the managing committees of WUA. These policies assume that women should be able to make autonomous decisions that allow them to benefit from the labour they contribute to irrigation activities. Nepali women are involved in irrigation, so they should be able to participate in decision-making bodies.[14] The subsequently ratified irrigation regulation and policies which emphasise that women take executive roles in managing committees, have fostered this belief.

These policies, however, have severe shortcomings. One glaring problem is that they have lump women together into a homogeneous group. They overlook the internal institutionalised differences among different groups, types, and classes of women. Women's needs and interests differ according to class, ethnicity, religion, age and sexual preference. Studies of women in irrigation conclude that household size and structure, ethnicity, class, age and education are all factors that (depending on what category a woman falls into) encourage or discourage her participation in irrigation processes (Ghimire, 1996). Though it is mentioned that women should be involved in the managing committees of WUA, irrigation regulations are silent about the criteria of membership.

Since there are different categories of female members in WUA whose participation varies, it is not sufficient to simply say 'women' should be involved in WUAs and the

WUCs. Policies must define which types of women they pertain to and lay down the criteria for their selection.

Although Nepal's irrigation policies, by advocating women's empowerment, seem to be based on the GAD paradigm, they, in fact, overlook a basic GAD premise: that women are not a homogeneous group but that their roles differ according to their class, ethnic group, family structure, etc. Nepal's policies, in that they see women as one homogeneous, actually take a WID approach. They imply that simple inclusion of women on the managing committees of WUA will help development efforts be more effective and efficient. They place more emphasis on what development needs from women than on what woman irrigators need from development. GAD, on the hand, argues that women have two different needs: practical and strategic.

PRACTICAL AND STRATEGIC GENDER NEEDS

Maxine Molyneux, a noted contemporary feminist, was the first to use the terms 'practical and strategic needs and interests', the practical needs of women are those needs that fit into their socially accepted gender roles. They are practical responses to an immediate perceived necessity like the provision of water, health care, or employment. They are often concerned with inadequate living conditions but also correspond with gender stereotypes. The satisfaction of practical needs does not challenge the gender divisions of labour in society. Strategic gender needs, on the other hand, are those needs, which women identify because of their subordinate position in the society. If these were met, the current imbalance of power relationships within a patriarchical society would be altered to the benefit of women.

Strategic needs relate to the abolition of the sexual division of labour, freedom of choice over child bearing, and removal of institutionalised forms of discrimination. It includes issues such as legal rights, domestic violence, equal wages and control over one's own body. Meeting strategic gender needs helps women achieve greater equality in society. Because meeting strategic needs changes the existing gender roles, it also challenges women's subordinate position. Some have criticised the term 'needs' because the term suggests that women are passive recipients of assistance: they suggest that 'interest' is a more active concept because it implies that women themselves define their demands.[15]

Getting adequate and equal amounts of irrigation water in a timely fashion is an important practical need of women. Thus having access to the water in an irrigation canal for domestic use is an important practical need of women. Studies show that irrigation water has multiple uses. If an irrigation canal passes near a household, its members especially women, use the water for many purposes, including washing clothes and dishes and providing drinking and bath water to cattle. These are important, but gender-biased needs of women. After a formal WUA is formed, however, the priority of any given canal

is awarded exclusively to irrigation and the daily requirements of women are not considered. Article 7(1) of the Water Resource Act of 1993 does, it must be said, specify the order of priority in the purpose for which water resources can be used.

The Act lists drinking and domestic purposes as the top priority; uses related to irrigation, agriculture and hydroelectricity follow. At first glance this Act seems to promote equity for women because it is primarily they who use water for domestic purposes. In reality, once a formal WUA is formed they can no longer use canal water except for irrigation. Their practical needs are sidelined. The Act has no provision for safeguarding either the needs or prior uses of women.

Providing for the representation of women in WUA aims to address the larger strategic needs of women. Being an executive member gives women greater bargaining power over men and can ultimately serve to improve their status as they safeguard their practical needs and water rights. Studies show that women have fewer land and water rights than men do (Pradhan, 2003). They have access to water only through membership in a household. Since this is the case, it is only when women are targeted using a quota system that they get to participate in water-related committees. Membership in an executive committee, however, is not open to all people (Sharma, 2001).

Because irrigation is a social activity, it subsumes a particular relationship between the men and women and other members of a household. The relationship is based upon both cooperation and conflict. Women usually perceive their interests—rightly or wrongly—to be bound up with the other members of the household. If the men are present in a household or if there is cash to spend on hiring labourers, then women might not feel a need to nor interest in participating in a WUA. If this is the case, the quota arrangement may force them to sacrifice the little time they had to themselves. It should be ensured that, in the name of empowering women, they are not burdened with additional work.

No less important than the issue of women's participation is the issue of the tenancy of the irrigators.[16] Membership criteria based solely upon landownership excludes tenants and sharecroppers from WUA. Policies need to make provisions to include these active farmers instead of absentee landowners.[17] Research has shown that women prefer to disseminate information informally and that they feel more comfortable in small groups than the large ones.[18] Thus instead of stating that women should be included in WUA and WUC, provisions should provide them participation in informal and small committees.

PREVAILING SITUATION AND OVERCOMING THE IMPASSE

The Irrigation Policy of 1992, the Irrigation Regulations of 2000 and the Irrigation Policy of 2003 are important because they have made women in the development process visible. However, a gulf exists between their proclamations and the end they seek. This gap highlights

the need to take into cognizance practical as well as strategic needs when formulating policies to strengthen women's role in irrigation. While endeavours for women at the micro levels are geared towards satisfying the practical needs of women, the women's movement currently taking place in Nepal is concerned with large, long-term strategic gender needs.

Tamang (2004) writes that the women's movement in Nepal can be said to have begun as early as 1917 and that it has passed through three distinct stages till now. In the first phase (1917-1949) women's committees were formed to raise the status of women, especially by encouraging them to participate in political activities conducted against the Ranas. In the next stage (1950-1960) different women's organisations with different political ideologies were established. The third period (1960-1990) of Nepal's women's movement was influenced by international development discourses centred on welfare programmes, as well as by the internal social-political ideology of the party-less *panchayat* system. The fourth period, which it currently is, is the period after the 1990s during which NGO activities increased, and, through the influence of their focus on women's empowerment (a strategic need), Nepali women have become more active.

Bhattachan (2001) suggests that the Nepali women's movement was started by and continues to be nurtured by high caste women with good economic backgrounds. In due course, it was encouraged by donors, including NGO and INGOs. It is currently centered in the Kathmandu Valley. The women's movement has raised issues such as equal property rights, the reservation of seats in different political positions, jobs and education. Since the post-1990's it has learned toward meeting women's strategic needs; as a result, various micro credit programmes which address women's practical needs have been overshadowed.

Credit and technology programmes implemented for women have been criticised for focusing in women's skill in nutrition or traditional handicrafts, increasing their workload and marginalising women from the development process. This is not to say that the programmes were entirely ineffective; if for example, these shortcomings are checked and productive groups are linked to irrigation, then the immediate monetary gains might promote women's participation in irrigation management. These productive cooperatives would help women meet their needs in terms of income, health and education. They could act as incentives for women to be involved in irrigation and could slowly constitute the space where women come together to exchange their experiences and problems regarding irrigation.

These arrangements could help women meet their practical needs on the one hand and, on the other hand, be the forums through which women could collectively articulate their interests and work together towards meeting their strategic needs. The practical and strategic needs of women must be seen as complimentary and convergent, they cannot work at cross-purposes. There is a need for more research into how incentives such as those mentioned in the irrigation policies could address women's immediate practical needs as well as work towards fulfilling their strategic gender needs.

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NOTES

[1] *The Status of Women in Nepal*, a multi-volume series of study was carried out in the 1970s to assess the productive roles of Nepali women. These studies showed that women contribute labour to both household and farm activities and that they have influential roles in deciding about certain activities such as crop seed selection, use of organic manure, and choice of food for daily consumption. They concluded that the decision-making roles of women and men vary with the type of activity undertaken and with ethnic group. Upadhaya (1996) writes that these studies are similar in that they examined women from the paradigm of development and confirmed the multifarious nature of women's situations across the country. Acharaya and Bennett (1983) discover that in several groups men do more work in what the authors call 'sphere one activity' (including cooking, serving, cleaning, shopping and child care); notably, Tharu-Sukraware men worked 7.29 hours per day in this sphere while women work just 4.97 hours (Pitt, 1986).

[2] Many studies have explored the participation of Nepali women in irrigation management . Pradhan, (1989); Bajracharya, (1994) Zwarteveen, (1995); Zwarteveen, and Neupane, (1996); Ghimire (1996); Beckman and Beckman (2000); Bajracharya (2000); Dawadi (2001); Koppen *et al.* (2001); and Udas (2002); demonstrate that Nepali women are involved in irrigation.

[3] The Irrigation Policy of 1992 (First Amendment of 1996) states "Women's participation in the WUA will be encouraged and it should increase to at least 20% in the executive board". The Irrigation Regulations of 2000 states that "users desirous of using any irrigation system developed and operated by His Majesty's Government shall be required to constitute a user's association having an executive committee not exceeding nine members, at least two of whom are women members".

[4] The Irrigation Regulations of 2000 was amended in 2003. This First Amendment states that there should be eleven members in the executive committee of a WUA. There should be at least 33 per cent of whom are women and two are from socially and economically disadvantaged communities.

[5] According to Tamang (2005) British resident Mary B. put forward the concept of liberal feminist in the 18th century.

[6] The Women Farmers' Development division was established in the Ministry of Agriculture. The Child and Women Development Section was established at the National Planning Commission (NPC). The Women Education unit was established at the Ministry of Education. And a WID cell was established at the Water and Energy Commission Secretariat in the Ministry of Water Resources. The National Council for Women and Child Development was established at the National Planning Commission in 1995 (Bhadra, 2001).

[7] He defines social organisation as "the patterns of social behaviour and interactions". 'Institutions', according to Coward (1985), is "a generic concept used for varieties of rules that help pattern social behaviour and includes norms, folkways, mores, customs"

[8] The processes of IMT vary, to some extent, from project to project within the DoI (Sharma, 2004).

[9] The irrigation scheme studied in the hills was the Angutar Kulo in Nuwakote; that in the Tarai was the Garam Jhoda Sinchai Ayojana in Morang.

[10] The problems women face for night irrigation relate more to the issues of social constraints (as women should not walk in the dark) than physical constraints: It is possible they might encounter drunk men. Women involved in night irrigation usually ask other women or a male relatives to join them.

[11] Beckmann and Beckmann (2000).

[12] Pradhan (1989).

[13] The West Gandak Irrigation System is one of the largest irrigation schemes handed over (except the headworks) to its WUA under phase I of the Irrigation Management Project. For various reasons this irrigation system is not currently functioning properly. One important reason is that the system was handed over to the users before they had adequate social and technical training in how to manage the system by themselves (Personnel communication with Lok Prasad Sharma, sociologist, Irrigation Department, Jawalakhel). This example needs to be used with caution because the irrigation system receives water from the Gandak Barrage built under the Nepal India agreement of 1959. Functionaries at the DoI acknowledge that supply and reliability are major concerns.

[14] Udas (2002) writes that the mere formulations of policies do not mean that they will be implemented accordingly as rural women may not be aware of changes made at the central level.

[15] Needing is not passive, It's a necessity for survival. Hence it might be argued that using the term 'interest' could signify the reduction of women's survival needs to mere interest.

[16] The size and structure of land holding in the country are very skewed. In 1990 the wealthiest five per cent possessed about 40 per cent of the land while the bottom 60 per cent possessed only 20 per cent of it (Shrestha, 2003). Since the amount of land that can be held is determined by Land Ceiling Acts, landowners usually have tenants or sharecroppers farm their land.

[17] Sometimes the criteria for membership are based upon land utilisation rather than land ownership as shown in a study conducted by Udas in 2002. Bajracharya (2000).

[18] Study of the Tarai irrigation scheme shows that Tharu women are most comfortable discussing their problems informally while going to *haats*. Wile at the markets, women often disseminate information from their relatives and neighbours. If an executive member lives nearby, then women most often go to his or her house to discuss their problems.

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STUDY OF WASTEWATER IRRIGATION IN KATHMANDU VALLEY

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ABSTRACT

The lack of adequate wastewater facilities and lack of rainfall during the dry season have led to the use of wastewater in agriculture in the Kathmandu Valley but wastewater irrigation has never been investigated in the monsoon climate of Nepal. This paper investigates areas of wastewater irrigation and determines wastewater irrigation practices in Kathmandu Valley.

INTRODUCTION

Irrigation using wastewater has recently emerged as a focus of study in the developing countries like Nepal. Farmers are turning to wastewater, as it is a reliable source of irrigation to fulfill their increasing water needs even during the dry period. Waste water irrigation is practised in both arid and humid regions. In arid regions, wastewater is especially valued for its reliable supply (Van der Hoek *et al.*, 2002). Whereas in humid regions, the use of wastewater in agriculture is largely the result of the unplanned pollution of irrigation sources with wastewater (Rashid-Sally *et al.*, 2002).

The subject of wastewater irrigation has never been investigated in the monsoon climate of Nepal. The Kathmandu Valley is a burgeoning metropolitan area surrounded by agricultural lands. The lack of adequate wastewater facilities and lack of rainfall during the dry season, as well as other factors, have led to the use of wastewater in agriculture in the Kathmandu Valley. This study aimed to investigate areas of wastewater irrigation and determine wastewater irrigation practices.

METHODOLOGY

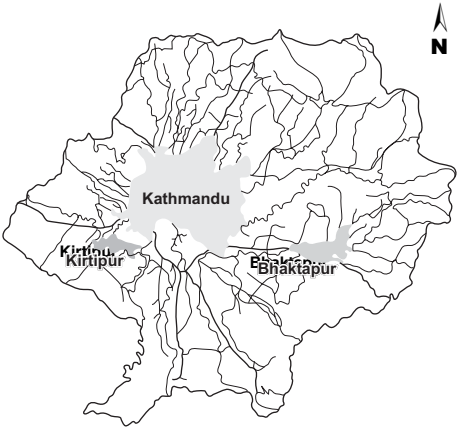
Farmer survey

Bhaktapur and Kirtipur were chosen as a study areas, where necessary researches were performed. One hundred and nine farmers from Bhaktapur and Kirtipur were interviewed regarding land holdings, crops, irrigation practices, and health. This study purposely sought out farmers thought to be using wastewater for irrigation.

Water quality data

Farmers in both case study areas irrigate their land with wastewater from the polluted sources. Water quality data for the Kirtipur Case Study area was obtained from the Kirtipur Environmental Mapping Project (NSET, 2000). To gauge the extent of the pollution in the Bhaktapur Case Study area, samples were taken from: the Hanumante River and the Khasyang Khusung Khola. Samples were collected from both the upstream and the downstream of untreated wastewater discharges of the rivers.

FIGURE 1
STUDY AREA WITHIN KATHMANDU VALLEY



Kirtipur water quality

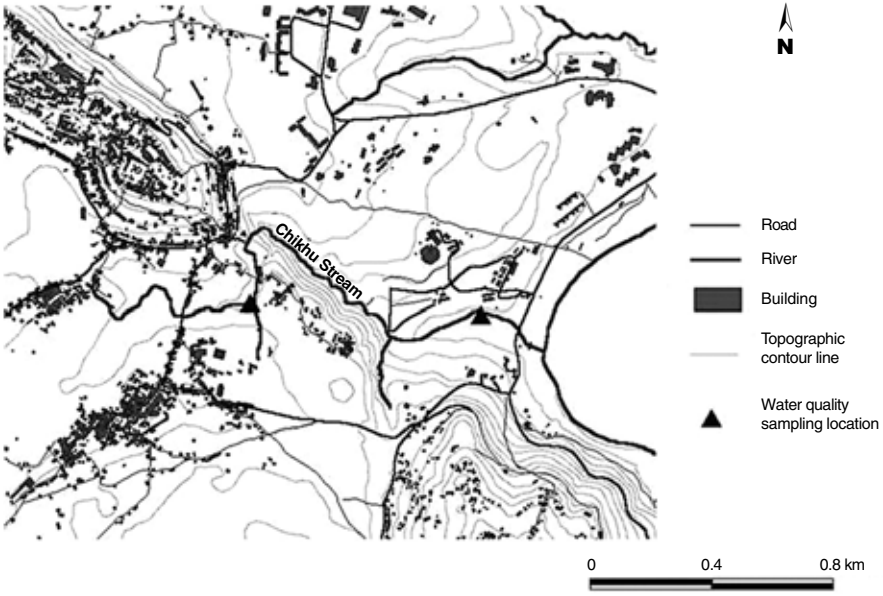
Data of Water quality from Kirtipur's Chikhu Khola indicates a severely polluted stream (table 1). In February, at the upstream location (figure 2), values for biological oxygen demand (BOD), chemical oxygen demand (COD), nitrate, ammonia and fecal coliforms are equivalent to those found in highly concentrated raw sewage. The majority of the farmer interviews were carried out near the upstream sampling location.

TABLE 1
CHIKHU KHOLA WATER QUALITY DATA

	Sampling Locations			
	Upstream		Downstream	
	Sept. 1999	Feb. 2000	Sept. 1999	Feb. 2000
Temp	20	16	20	12
pH	7.40	7.20	7.70	7.64
Cond. (umhos/Cm)	333	1028	492	398
Ammonia (mg/l)	10.98	81.6	12.63	25.5
Nitrate (mg/l)	1.44	6.09	6.31	1.37
Dissolved Oxygen (mg/l)	1.95	0	4.28	4.5
BOD5 (mg/l)	5.64	339.00	14.82	11.80
COD (mg/l)	65	640	40	31
Total Coliform Count (MPN/Index 100ml)	1.1×10^3	1.1×10^6	1.1×10^3	1.1×10^5

Source: NSET, 2000

FIGURE 2
KIRTIPUR WATER SAMPLING LOCATIONS



Results

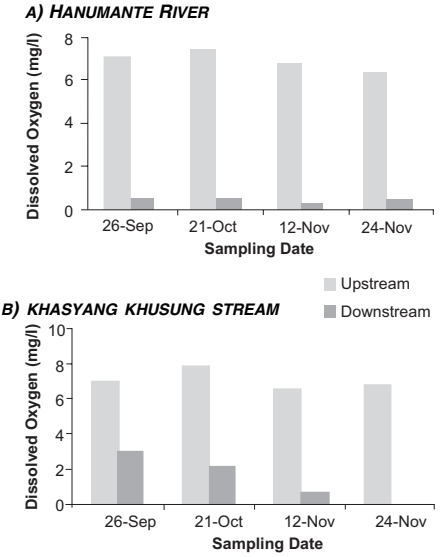
Bhaktapur water quality

Water quality results from the Bhaktapur also indicate severely polluted waters. The dissolved oxygen (DO), biological oxygen demand (BOD) and fecal coliforms are the major indicators of domestic wastewater contamination.

Dissolved oxygen (DO)

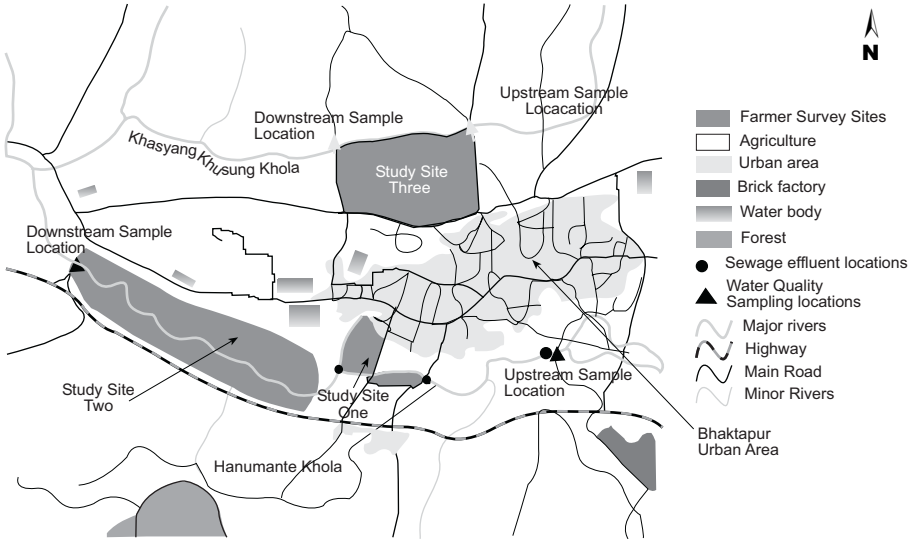
Dissolved oxygen (DO) levels dropped dramatically in both streams between the upstream and downstream sampling locations. According to Metcalf and Eddy (2000), DO level greater than 5 mg/l is typical raw water standard for a drinking water treatment plant. All eight downstream samples were far below 5 mg/l. The lowest DO level, 0.0 mg/l, was observed in the

FIGURE 3
DISSOLVED OXYGEN



Khasyang Khusung Stream on November 24th. The average downstream DO concentration for the Hanumante and Khasyang Khusung Rivers was 0.4 and 1.38 mg/l respectively.

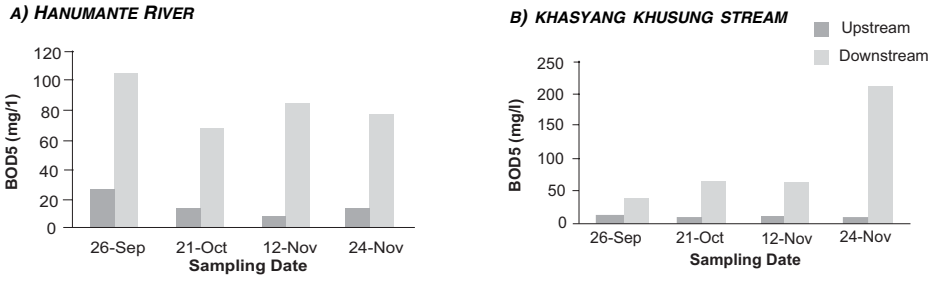
FIGURE 4
BHAKTAPUR CASE STUDY MAP



Biological oxygen demand (BOD)

The Biological Oxygen Demand (BOD) levels in both rivers indicate severe water pollution. A typical BOD value for raw water sources to be treated and used for drinking water is 10 mg/l. All samples handily exceed this limit. One sample from the Hanumante River exceeded 100 mg/l and one sample from the Khasyang Khusung Stream exceeded 200 mg/l. These BOD levels are equivalent to those of weak and medium strength domestic sewage respectively (McGhee, 1991).

FIGURE 5
BIOLOGICAL OXYGEN DEMAND (BOD)



Fecal coliform

Fecal coliform levels were noticeably higher at both downstream locations. The highest fecal coliform level ($2.2x10^8$) was sampled in the Hanumante River. All downstream fecal coliform levels exceed the FAO irrigation standard for vegetable irrigation (10^3 cts. per 100 ml.).

TABLE 2
FECAL COLIFORMS (COUNTS PER 100 ML.)

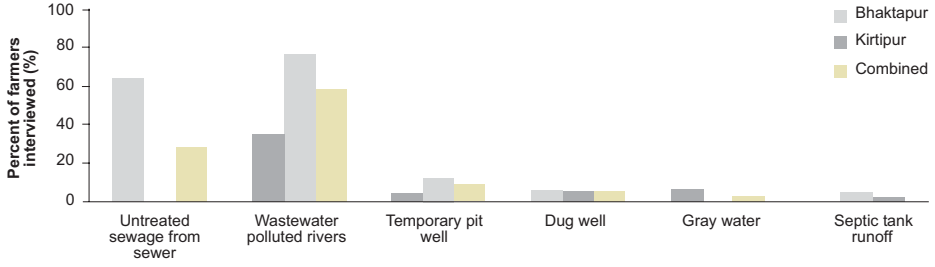
	Hanumante River		Khasyang Khusung Stream	
Date	**Upstream**	**Downstream**	**Upstream**	**Downstream**
26-Sep-03	290	2.2×10^8	5×10^3	7.1×10^5
21-Oct-03	350	1.48×10^5	640	3.9×10^5
12-Nov-03	260	3.2×10^5	250	4.3×10^5
24-Nov-03	1460	1.49×10^5	230	1.96×10^5

Farmer Survey Results

Irrigation sources

Farmers in both case study areas irrigate from a variety of sources: sewers, wastewater-polluted rivers, temporary pit wells, dug wells, gray water runoff, and septic tank runoff. The most common source in Bhaktapur is untreated sewage. In Kirtipur, it is the wastewater-polluted Chikhu Stream. The findings are shown in figure 6.

FIGURE 6
IRRIGATION SOURCES



Wastewater irrigation

Both, in Kirtipur and Bhaktapur combined, thirty-four farmers are irrigating their land with untreated domestic sewage while sixty-three farmers are irrigating with diluted sewage taken from polluted rivers and streams (Table 3). Approximately four hectares are irrigated with untreated domestic sewage and nearly eight hectares are irrigated with diluted sewage from rivers.

Wastewater health awareness

Slightly more than half of the farmers have either themselves or had their family member, experience itching and blisters on the hands, feet and lower legs. Only two farmers have suffered from intestinal parasites, while five per cent, all of who are Bhaktapur farmers, claim to be 'accustomed' to the polluted water. This means that they haven't noticed any symptoms as a result of their contact with wastewater. However, eighty-nine per cent of the farmers interviewed are aware of the fact that wastewater irrigation can negatively impact health.

Intestinal parasites likely affect a higher percentage of farmers than the results show. By only questioning farmers, and not examining stool samples, this study likely underestimated the incidence of intestinal parasites among wastewater farmers. A study in Pakistan found an eighty per cent incidence of the hookworm intestinal parasite in male farmers irrigating with wastewater (Ensink *et al.*, 2002).

TABLE 3
KIRTIPUR AND BHAKTAPUR COMBINED IRRIGATION SOURCES

	Direct sewer	Wastewater polluted rivers	Total
Number of farmers using source	34	63	97
% of farmers using source	31	58	
Land area (ha.)	3.8	7.7	11.5

Wastewater flooding

Flooding of wastewater due to the lack of properly managed sewage has become a significant hazard for farmers located adjacent to the Chikhu Stream in Kirtipur. Among the farmers interviewed, three out of every four of them stated that, their land is regularly flooded during the monsoon season. Furthermore, twenty-three farmers (38 per cent) stated that frequent flooding damaged their crops which is highly polluted and can physically damage crops, as well as lead to over-fertilisation. Chikhu Stream floodwaters often leave behind mounds of garbage, animal bones, and glass.

DISCUSSIONS

Perceptions of farmers

Farmer perceptions of wastewater irrigation in the Kathmandu Valley vary significantly. Kirtipur farmers have a negative impression of wastewater irrigation. This is likely due to the negative effects of wastewater flooding, such as over-fertilisation of crops and residual

garbage, that they experience. They are not happy about being forced to irrigate with 'dirty' water. This perception mirrors that of farmers in other humid regions such as Vietnam (Rashid-Sally *et al.*, 2002), who irrigate with wastewater because it is their only source of irrigation water.

Conversely, nearly seventy per cent of the Bhaktapur respondents seek out untreated wastewater by plugging municipal sewers and diverting the flow to their fields. Bhaktapur farmers take advantage of this reliable source of irrigation water by irrigating entire plots of vegetable cash crops in the dry season. Other Bhaktapur farmers irrigate with wastewater-polluted rivers because it is the only source of irrigation water.

Water quality

The two Bhaktapur rivers Khasyang Khusung and Hanumante, as well as the Chikhu Stream in Kirtipur, are severely polluted with municipal wastewater. They are most polluted during the dry season when background river flows decrease. Both the Chikhu and the Khasyang Khusung Streams are ephemeral and thus likely composed entirely of wastewater during the dry season. All rivers exhibit BOD, DO, and fecal coliform levels equivalent to those found in raw sewage during this season. Therefore, farmers irrigating from these water bodies are practising untreated municipal wastewater irrigation.

Health impacts

The high incidence of skin problems among the farmers (55 per cent of interviewees) is dramatically higher than the incidence of skin problems in a wastewater irrigation study in Pakistan (3%) (van der Hoek *et al.*, 2002). The Pakistan study did not find significant incidence of skin problems in the wastewater-exposed population relative to the non-exposed population (van der Hoek *et al*. 2002) Although this study of Kathmandu farmers did not survey a control, non-exposed population, farmers were convinced that work in wastewater-irrigated fields resulted in skin itching and blisters.

The high incidence of skin problems, especially in Kirtipur (63 per cent of farmers interviewed), is likely due to cropping choice and wastewater flooding. Kirtipur farmers often flood irrigate paddy crop with wastewater-polluted river water. Prolonged contact

TABLE 4
COMBINED HEALTH IMPACTS (% OF FARMERS INTERVIEWED)

	Aware of negative health impacts	Accustomed to polluted water	Symptoms		
			Skin problems	Headaches	Intestinal parasites
Bhaktapur	92	11	45	3	2
Kirtipur	87	0	63	5	2
Combined	89	5	55	4	2

with flooded land, compared to furrow irrigation of vegetable crops for example, likely increases the incidence of skin problems.

CONCLUSION

Informal wastewater irrigation with untreated municipal sewage and wastewater-polluted rivers is occurring in the urban and peri-urban areas of the Kathmandu Valley of Nepal. The sources of wastewater irrigation are varied in type and degree of pollution. Some farmers in the Bhaktapur case study irrigate directly from sewers with untreated undiluted municipal wastewater while others irrigate with diluted municipal wastewater from rivers. The Kirtipur Case study provided a new type of wastewater irrigation: involuntary wastewater flooding.

This is the first study in Nepal on wastewater irrigation. There is no institutional awareness or regulation of wastewater irrigation in the country. The adoption of wastewater irrigation guidelines in Nepal would be a crucial first step in addressing the health concerns currently faced by farmers.

Alternatives to traditional sewage treatment plants in the Kathmandu Valley have shown some promise, such as the Teku septage treatment facility and constructed wetlands. However, sewage treatment facilities and treatment wetlands are small-scale technologies and cannot solve the overwhelming wastewater disposal problems in the Kathmandu city.

Other researchers have suggested that properly managed wastewater irrigation can be used to mitigate the polluting effects of municipal wastewater discharge to local water bodies (Scott *et al.*, 2000). As wastewater is applied to crops, naturally occurring treatment processes take place, and the water quality of the wastewater improves. This potentially positive aspect of wastewater irrigation would be difficult to exploit in the Kathmandu Valley. There is simply not enough properly situated agricultural land in the valley to absorb the large volumes of generated wastewater.

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SLEEPING WITH THE ENEMY: DICHOTOMIES AND POLARISATION IN INDIAN POLICY DEBATES ON THE ENVIRONMENTAL AND SOCIAL EFFECTS OF IRRIGATION

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ABSTRACT

Large-scale, government-managed canal irrigation represents the technocratic approach to water development. Large-scale irrigation faces many problems but they have been relegated to the periphery in the water debate generally and about large dams in particular. It has given rise to dichotomous thinking and polarised politics. This paper explores these issues in case of large canal irrigation in India. The debates suggest implications for institutions, science and technology and developmental practices which need to be viewed within the domain of new approach.

INTRODUCTION

Large-scale, government-managed canal irrigation usually figures as the enemy in the dichotomous world of environmentalists. It represents the technocratic approach to development and is seen as oblivious to local needs and knowledge. It is the abode of the Green Revolution, inhabited by privileged, market-oriented, large farmers who degrade the land with excessive applications of fertiliser and pesticides, create widespread waterlogging and salinisation through over-irrigation, and compete with small, marginal farmers and even push them off their rain-fed fields. Canal irrigation has produced a rural elite who wield a lot of political power to the detriment of non-landowning food buyers, particularly urban consumers, by keeping food prices artificially high.

The image of canal irrigation as one malignant influence on ecological and human development has been strengthened by the debate on large dams as it has evolved in India. In fact, the debate on the negative ecological and social effects of large dams has over-shadowed the discussion on what happens inside existing large-scale canal irrigation systems, where dam-damage has already been done. There is extensive public and academic debate on the ecological and social effects of submergence and on the displacement and rehabilitation issues related to dam building but very little on the waterlogging, salinisation and other environmental hazards caused by existing canal systems.[1] As an intended or

unintended consequence of the debate on large dams, discussion about the operational problems of canal irrigation has been pushed into the background, critical research attention has been shifted elsewhere,[2] and the irrigation establishment has become extremely defensive towards the raising of issues by 'outsiders'.[3] The environmental concern movement has been very influential in reshaping the water resource management debate,[4] but, at the same time, the way the interaction with the water resource establishment has taken place has paralysed the sector. Progress in water sector reform in India has been very limited.

This paper does not explore the details of the environmental and social problems related to canal irrigation or the intricacies of the counterpoint, its contribution to national food security and other developmental benefits.[5] It addresses a different issue: it is my contention that there is a deadlock in the sector as a result of dichotomous thinking and polarised politics. This deadlock exists on the environmental front as well as on the management and human development fronts and in terms of analysis and thinking as well as new policy initiatives. The paper suggests that this problem is not exclusive to canal irrigation, though it has taken an extreme form in this sector. Dichotomisation and polarisation also apply to debates and interventions regarding water resource management in general.

The question raised in this paper is why dichotomous thinking and polarised politics prevails in relation to canal irrigation and to water resource management in general. The answer is that this worldview reflects two characteristics of India:

1) A lack of institutions in the polity where development approaches and priorities can be negotiated by interest groups, and
2) The existence of a water resource science that has insufficient linkages with real-world water problems.

The paper attempts to provide a critique, in the Marxist sense of the term, of the present water resource management discourse and practice. It tries to show how that discourse and practice reflect particular features of the society in which they exist, and how they fail to overcome the limitations caused by that embeddedness.

At the normative, policy level the paper argues that both institutional and technological innovation need, to be democratised by adopting a framework of negotiated development. This involves the creation of institutions in which different interest groups can meet, interact, and negotiate the technical and social transformation of the water resource management system. It is argued that such multi-stakeholder institutions are conspicuous in their absence from the Indian polity. That polity is characterised by a 'winner takes all' approach that operates in a social structure with very few vertical solidarities.

There is also a large institutional gap between the centralised state bureaucracy and local (basically village)-level decision-making bodies. Apart from institutions, the process of negotiated development requires a water resource science that engages with real-world water problems in a comprehensive manner. Such a science is largely absent at present. It is suggested that the emerging international and national bandwagon of integrated water resource management (IWRM) may provide a vehicle for introducing new technical and institutional approaches in the water resource sector on a larger scale than the experimental and local scale at which they now exist.

My argument to support these statements is laid out as follows. In the following section, I substantiate the claim that dichotomous thinking and polarised politics prevail in the water resource sector. Then, I continue to discuss a number of encouraging initiatives and processes which aim at negotiated development by multiple interest groups. In the next section, I summarise the critique of the present water resources discourse and practice that follows from the two preceding sections. Lastly, I outline some implications of the argument for research and praxis. For those unfamiliar with canal irrigation, I have included Box 1 as a short introduction to the field.

BOX 1:
THE PROBLEMS WITH CANAL IRRIGATION

Irrigation systems can be classified in different ways. One way is based mainly on differences in irrigation technology and distinguishes among canal, tank and lift irrigation. Administrative classification in contrast identities, major, medium and minor irrigation, which is based on the size of systems' command area (>10,000 ha, 2000-10,000 ha, and <2000 ha respectively). Yet another typology separates government or agency-managed systems, farmer-managed systems, and privately managed systems. 'Canal irrigation' as a term is generally used to refer to large-scale, government-managed surface irrigation systems, and in practice, is thus a composite category. In many cases they are reservoir-fed systems.

Huge sums of money have been invested in the expansion of canal irrigation since Independence, it was, in fact, at the heart of the Nehruvian development model. The problems managing these systems were recognised as early as the mid-1960s, but acquired policy prominence in the 1970s as part of an emerging international water management debate (see Chambers (1988) for an overview). This debate focussed on the reasons for poor performance and inequitable water distribution. Taking its cue from institutional transformation processes in the Philippines towards more farmer control in irrigation management, it introduced the notion of 'participation'. This management debate has recently raised the question of the institutional reform of the irrigation bureaucracy. The main environmental issue in canal irrigation is waterlogging and salinisation. It is hard to get reliable data on the extent of this problem, but it

is a serious problem, particularly in flat, alluvial regions. Other environmental issues are health and water quality issues, but these have received much less attention. Though these environmental problems partly come with the nature of the technology and its design principles, they are mostly 'second order' problems in the sense that they derive from poor management.

In the same period, but largely independent of this 'internal' debate on canal irrigation, environmental and social concerns started to be raised about the building of large dams whether for hydropower or irrigation. The displacement and ecological destruction related to submergence and the problems related to resettlement and rehabilitation are the central issues. This concern has developed into an overall critique of the development paradigm that large-scale water infrastructure development is seen to represent. That paradigm has been described as being a top-down and technocratic, and as advocating resource-intensive, market-oriented agricultural development without given attention to the livelihoods of the poor or marginalised or to ecological sustainability.

The following are some of the fundamental development issues integral to canal irrigation/ large-scale water infrastructure development.

1) The inclusion, exclusion or displacement of people by virtue of delineating command areas and choosing dam sites. This raises broader questions about a) canal irrigation as part of overall water resource management in a region, b) allocation and (water) rights, and c) technical options and alternatives to centralised water control.

2) The next is the rationing problem. Many of India's canal systems have been designed to spread water thinly over many villages and farmers. Water is scarce by design. In practice, water is often appropriated by a certain segment of the farming community, leaving others deprived. (In) equity in access to water resources is intimately linked to the type, size and distribution of agricultural production and employment and on the occurrence of waterlogging and salinisation.

3) Lack of internalisation by the irrigation bureaucracy of environmental concerns and other new demands on the sector, like increasing overall water scarcity and transparency and accountability in management. Institutional rigidity in the irrigation sector is substantial, and efforts to reform irrigation and water agencies are in the very early stages.

4) Issues of productivity (yield gap, water use efficiency) and financial sustainability of the sector. These relate to broader issues of agricultural pricing, technological innovation, and government budgets and subsidies.

In short, the environmental issues related to canal irrigation have to be seen from a broad perspective.

DICHOTOMIES AND POLARISATION IN WATER RESOURCE MANAGEMENT

This is the bad news section of the paper. It discusses a number of examples and issues that show the prevalence of dichotomous thinking and polarised politics in the water resource sector.

In canal irrigation there are only rich people

While writing the first draft of this paper I discussed water management issues with staff from an NGO working on watershed development, training SC/ST, electing women and minorities to *panchayat raj* institutions, and other matters. The staff stated, 'We feel that in canal irrigation we mainly find more privileged people'. This very common statement and perception is one of the reasons why very few NGOs are active in the canal irrigation sector.[6] There is of course, truth in this view.

Canal irrigation systems have been core Green Revolution areas[7] and have supported the emergence of politically vocal and influential farmers' movements (Brass, 1995) that are, in Bardhan's view, part of the triangle of dominant elites who control the Indian political economy: industrialists, state officials and large farmers (Bardhan, 1984).

This perception can however, be questioned. At the empirical level, it can be argued that in canal systems substantial areas are deprived of water.[8] In terms of livelihoods and poverty, villages in these deprived areas cannot be distinguished from those outside the formally designated command area. A second empirical point is that canal irrigation systems, comprise not only farmers but also many landless and near-landless labourers, some of whom are seasonal migrants from non-irrigated areas. The distribution pattern of water, water use efficiency, productivity and quality of management influence the employment generated in irrigated agriculture (see Chambers, 1994). The visibility of large farmers in canal irrigation systems should not hide from the observer's view the social differentiation extant in these systems.

At the strategic level, what is often implicit in the 'canal-irrigation-is-for-the privileged' perception is that those who want to work for the benefit of poor and marginalised groups should work with these groups directly and preferably with the 'poorest of the poor.' There can be no objection to this commitment in general, but it is an empirical question where the leverage points for enhancing the human development of the poor and marginalised are located.

But even if it is an individual's choice is to work with and from the perspective of the 'more deprived' in non-irrigated areas, canal irrigation cannot be ignored. The above reference to seasonal labour reveals that canal irrigation systems, though often perceived as isolated systems, actually have many connections with their environment. These connections are physical through the hydrological cycle and the—acknowledged or unacknowledged—

multiple uses of the systems (for example, their relevance for drinking water supply and groundwater recharge). Social, political and economic connections also exist. Examples are how canal irrigation shapes class relations, how it shapes regional politics, and what the forward and backward economic linkages and multiplier effects of irrigated agriculture are.

The gist of this discussion is that compartmentalised views of (canal) irrigated *vs.* rain-fed agriculture, operating through homogenised characterisations like 'for the rich' and 'for the poor,' cannot stand the empirical test and must, therefore, be reconsidered.

The debate on large dams

The history of and the positions taken by social movements, which oppose the building of large dams have been documented elsewhere in detail, and will not be discussed here (see, for example, Dhawan, 1990 and Singh, 1997). I limit myself to a few observations on the political deadlock that this debate seems to have reached.

The political terrain is now occupied by two parties that are both absolutely convinced of their cases. On one side there is the anti-dam movement, which considers the dam to be a form of state terror and ecological destruction. On the other side is an aggressive pro-dam lobby that sees dams as the only possibility for agricultural and overall economic development. The anti-dam movement blames the government and engineers-contractors lobby for being technocratic, callous and self-centred. At the same time these engineers blame NGOs and the social anti-dam movement for holding unrealistic ideas about small-scale development options. 'Small is beautiful' opposes 'big is beautiful'.[9]

It's not that there are no nuanced views available. In fact, elaborate proposals for alternative approaches to water resource and dam development are plenty. An example is a publication on how to redesign the Sardar Sarovar Project (Paranjape and Joy, 1995). But such proposals have never caught the imagination of either the dam establishment or the community of social activists. Or, to assess the situation more positively there was never any possibility of getting such compromise approaches discussed and considered seriously at levels where they could shape mainstream policy.

The observation I want to make is that the conflict of views and interests regarding the building of large dams has not led to any institutional transformation in water resource planning and development. The conflicts have not been 'internalised' and no process of 'social learning' has taken place. For a country that takes pride in being the largest democracy in the world this is somewhat paradoxical.[10]

That this is not a natural course of events can be shown using several examples. The success of environmental movements in other parts of the world lies exactly in the fact that 'internalisation' and 'social learning' did take place and that there is now a mainstream project of 'ecological modernisation,' particularly in the industrial sector.[11] Some of these examples are found in the water sector. I briefly discuss two of them.

The first is about the Netherlands. In 1953, after the southwestern part of the country was flooded in a February storm that coincided with high tides, and 2000 people and a lot of cattle lost their lives, the Dutch government designed the Delta Plan. This was a plan to close the estuaries and other river outlets by constructing high dikes. It shortened the coastline drastically and protected the land from the influx of seawater. In the 1970s, when the closing of the biggest estuary was being planned and prepared for, environmental concerns started being voiced. The closure, it was argued would permanently destroy a unique eco-system. A political debate followed, in which the safety and economic value of the land was pitted against the ecological, recreational and economic value of the water. After extended agitation and debate, a compromise was reached: a dam that would let the tide in during normal weather conditions but could be closed when there was a storm, was designed. The considerable amount of technical innovation that the civil engineers—who were at first absolutely in favour of permanent and full closure—had to introduce in order to be able to build this barrier, is now an integral part of their professional ethos. Every foreign visitor is taken to see this impressive piece of human ingenuity. Following a political and social conflict the environmental concern was internalised into a new technological design. This conflict was played out in parliament, but also through an endless number of studies, reports, hearings and meetings of the different interest groups.

The second example is from the USA and taken from Espeland (1998). In the early 1980s the Yavapai Indians in the American Southwest opposed the building of the Orme Dam by the USBR (the United States Bureau of Reclamation) because it would submerge a large part of their reservation. Legislation accepted under the Carter administration had made an environmental impact assessment (EIA) part of the project process. This tool was used to attempt to measure, compare and weigh the different interests and preferences related to the dam and to resource use. The Yavapai Indians won the argument, though they thought it was for the wrong reasons. In their view, the commensuration of all interests and preferences in one framework (using the neo-institutional economic theory of values, preferences and choice making) denied the different rationality with which they interacted with the natural environment. What is interesting in the context of the present discussion is that the use of the EIA tool and its political importance as a conflict mediator, led to the emergence of a new professional group, 'a new guard' of environmental assessment specialists, in addition to the 'old guard' of civil engineers and hydrologists who had earlier dominated the USBR. As in the Netherlands, the environmental concerns were indeed internalised though not everyone may have been altogether happy with the methodologies adopted.

To avoid the impression that the process of internalisation is unique to rich, industrialised countries, where working systems for mandatory public consultation may exist, I report briefly the results of an inventory of the existence of 'multi-stakeholder platforms in

water resource management' in three parts of the world: South America, Southern Africa and Asia. Using secondary literature, this study documents the emergence and functioning of institutions at the sub-basin and basin levels that have some degree of discussion, and planning of and decision-making on water resource management by different interest groups (different types of water users, like farmers, industries and urban domestic users; different government agencies; and eventual other parties).[12] These institutions would thus be located somewhere between micro-level local water management institutions and macro-level international committees for mediating cross-boundary water conflicts.

The study concluded that in South America such institutions are relatively prevalent, and either are initiated by governments or emerge as an outcome of social and political conflicts over water. In Southern Africa, a number of countries are establishing catchment councils, which have stakeholder representation, for water resource planning. In Asia, in contrast we found virtually no multi-stakeholders institutions. In India we could identify very few. The main ones are the initiative in the Sabarmati Basin to form a stakeholders' forum and the evolution of a dam-oustees movement in the Krishna Basin in Maharashtra (see below).

Apart from these few examples, the terrain of water resource management seems to be divided into local management systems on the one hand, and centralised, bureaucratic, top-down management systems on the other. Systems are either 'government' or 'village' with no institutional middle-ground with institutional mechanisms to negotiate water resource management and use at the basin or sub-basin level, or if one wishes to follow administrative lines, at the *mandal*, *taluk* or district levels. This is yet another paradox in an otherwise democratic set-up.[13]

The glorification of the community and the village

Another prevalent dichotomy in water resource discussions is that between past and present. The past tends to be portrayed as glorious, the present as problematic. This resonates strongly with the dichotomy between: traditional and modern, which features strongly in debates over tank irrigation.

Literature on tank irrigations abounds with assertions like the following:

> "Irrigation Tank is one of the best innovations in gravity irrigation systems in the world. It is an appropriate water harvesting structure in villages to preserve village eco-system, and it has got [sic] well integrated with rural culture. (…) Traditionally tanks were considered as village assets and were revered by the rural community. Basically Indian civilisation placed a great value on decentralisation of resources and political power which automatically set a limit to [sic] the size of the irrigation structure.

> Large-scale systems such as modern reservoirs would not have been compatible with the values and goals of the ancient Indian civilisation. The traditional irrigation technology is also ecologically sound." (Vasimalai and Shanmugam, 1993).
>
> "Our experience in organising farmers reinforces our conviction that farmers have the capability to organise themselves and to mobilise technical, financial and managerial resources to manage irrigation systems. It has been possible to replicate farmers' organisations in neighbouring areas. The degree of their efficiency and sustainability is directly related to how effectively the farmers have been motivated and inspired and how their organisations have been supported and fostered to blossom into self-reliant groups." (*Ibid*)

This perception that tank irrigation had a wonderful past is particularly strong among those who promote intervention programmes for tank rehabilitation. The physical rehabilitation of a tank (desiltation, repair of bunds, reduction of encroachment, catchment management) runs mentally parallel to institutional rehabilitation, which involves rejuvenating or reviving the traditional institutions of tank management.

Incisive criticism of such views can be found in Mosse's work on South Indian tanks (see, for example, Mosse, 1999, 2003; also see Shah, 2003). Some points relevant to the present discussion follow. Glorification of the past is unwarranted because effective tank management was often rooted in oppressive social relations, including coerced labour. In fact, some of the present conflicts over tanks are a result of the gradual emancipation of previously oppressed groups. Furthermore, in every historical period there is evidence of tanks in decline; there never was a 'golden age'. Lastly, the socio-economic and technological context of tank use has changed to so much that the issue is more properly seen as the *reinvention* of tanks rather than their *resurrection* or *revival*. The vocabulary of tradition depoliticises the discussion surrounding tanks.

Positing farmer-managed irrigation systems like tank systems as the logical or easy alternative to government-managed irrigation, notably canal irrigation, is a (gross) simplification. Each type of irrigation and, more broadly, each type of land and water resource management has its own problems.[14]

In canal irrigation too, a black-and-white worldview plays a role in discussions about the devolution of management responsibilities to the local level. The box used is that of 'the farmers' who, because they are seen as a homogenous category can readily form a 'water users association' as a collectivity in which joint, consensus-oriented decision-making is possible.

The dominance of water supply enhancement

There is a problematic similarity in approach between the antagonists involved in the village versus government dichotomy. Common to the approaches to water resource management of both NGOs/CSOs and government agencies is their focus on water supply enhancement.

An 'increase in supply' approach, which hopes to find extra water to solve problems and constraints, is very evident in the focus of government agencies' on dam building and infrastructure creation. As an aside it should be mentioned that this approach is strongly supported by how politicians operate. Politicians prefer to solve problems by bringing in new or extra water to a region rather than by addressing the more complicated issues of allocation and water use efficiency.

The supply enhancement focus is perhaps less easily recognised in the watershed development and water conservation programmes that NGOs/CSOs in the water sector favour but it is still there. Building check dams to enhance groundwater recharge, well-recharge techniques, and other technologies for water in-situ conservation are, at heart, strategies to make more water available in a particular area. Supply-side approaches tend not to address the following two issues:

1) The downstream effects of upstream conservation. When more water is conserved and used in upstream areas, downstream users may be deprived of what they feel are their historical rights. As long as watershed development and water conservation are done on a relatively small scale, the issue will not come to the fore very strongly. However, when such programmes expand to larger areas, the issues of allocations and rights across a basin become unavoidable. The micro approach of most watershed and water conservation initiatives seems ill-equipped to deal with the inevitable controversy.
2) The ongoing intensification of water use. When extra water becomes available in a given area, water use usually intensifies. The main reasons are the intensification and expansion of agricultural production and population growth. The question of what should happen after the extra water made available has been 'used up' is often not addressed. One reason it is ignored may be the implicit or explicit focus of watershed development and water conservation programmes on subsistence-oriented survival strategies and their tendency to equate ecological sustainability with 'no growth' local economies. Whether these are realistic assumptions is questionable (see below).

The gist of this discussion is that the issue of allocation, water rights and demand management at the regional level are insufficiently recognised in present debates on and approaches to water resource management. Ironically, the antagonists in that polarised debate have comparable blind spots in this regard.[15]

Crumbling tribunals

The allocation of the water which flows in Indian rivers is made through the Inter-State Water Disputes Tribunals. These Tribunals were established to allocate the waters of inter-State rivers to the respective States and to individual projects within those States. This system has worked well till recently, but now seems to be under severe pressure, as is suggested by the inability of the States of Karnataka and Tamil Nadu to settle the disputes regarding the Cauvery River in South India. The revision of the Cauvery agreement has led to a lot of political turmoil both between and within the two states. At present, the conflict is being mediated in a political council of chief ministers chaired by India's Prime Minister.[16]

What this case suggests is that in basins that are 'closing' (that is, where all water is committed and zero-sum games appear in allocation) the system of Tribunals is less than adequate to deal with the tensions and conflicts generated. The system can determine allocation for a long period by using a certain dependable supply as the standard, but it does not have any mechanisms for addressing short-term and medium-term operational issues (like the timing of supplies in a given year, handling conflicting demands at a given moment, and mitigating short-and medium-term scarcities). There are also no provisions for addressing water quality issues. Conflicts over all these issues will increase with increasing overall scarcity. The point is that the problems centred around the Tribunals illustrate the existence of an institutional gap in operational management at the basin and sub-basin levels and the fact that tensions and conflicts at these levels are on the increase.

The switch to abstract and high-tech water science

For those interested in the history of water engineering there has been an interesting shift in the post World War II and post-Independence period. One result of America's dominance and the decolonisation process after the Second World War has been the adoption of the American irrigation engineering approach by many countries. In the late 1940s and early 1950s many study trips were made to the USA to see the 'modern' irrigation systems developed there in the first half of the century. This is true for the institute where this author studied and worked for a long time, Wageningen University in the Netherlands, of the Philippines which literally almost copied the USBR manuals; and also for India. India used not only the USA but also the USSR and Eastern Europe as a reference for large-scale irrigation development.

Colonial powers had developed 'indigenous' imperial irrigation engineering traditions in their respective colonies (the British in India and Egypt, the French in North Africa and Vietnam, the Dutch in Indonesia). These were, to a large extent, distinct and regionally specific, as the types of irrigation and the contexts were different.[17]

One of the most striking features of engineering debates held in the first half of the 20th century in India is the orientation of the discussions towards field-level problems.

The sedimentation problem in the canals in the north was a much researched and discussed as a very practical managerial issue. There was extensive experimentation with different types of division structures which are the devices at the interface of government managers and farmer irrigators and whose type expresses as well as shapes the relation between these two (see Bolding, Mollinga and van Straaten (1995) for detail). Management issues translated into scientific discussion among engineers (who were British as well as Indian).

After Independence two things happened. The first was the orientation towards the abstract 'universal' science of hydrology, hydraulics and civil engineering as developed and practised in the USA (and the USSR). The second was a shift in orientation towards 'high-tech' engineering, notably the design of dams and large canals. The following anecdote illustrates these shifts. The last publication on the mundane artefact of the canal irrigation division structure from the Karnataka Engineering Research Station which I have been able to trace, was 1966. In the early 1990s its hydraulics research programme focused on topics like spillway designs for large dams. Though this author is unable to fully explain this transformation, the resonance of the universal science with the Nehruvian development model must have been an important factor.

This is not to say that the 'indigenous' tradition disappeared. It is still taught and used. But it has lost its central place and professional legitimacy, and it has stagnated. The vibrancy of the period from the 1920s to the 1940s is now absent. The worst part of this decline is that the orientation of irrigation engineering science towards field level operational issues has largely been lost.

The general point is that the opposition of 'modern Western science' and 'local knowledge' that can be found in a lot of critical discourse on water resources issues is based on an inadequate statement of the knowledge issue. This is not only because of the tendency to essentialise the two categories and, consequently, to glorify or demonise them.[18] I suggest that the central issue, at least as far as canal irrigation is concerned, is the arrested development and potential transformation of 'indigenous' colonial science after Independence. This science was 'modern' in many respects, but 'local' in others. One of its strengths was that it was much more 'real world'-oriented than the present vanguard of engineering and hydrological science.

TOWARDS NEGOTIATED WATER RESOURCE DEVELOPMENT

This is the good news section of this paper. It briefly discusses some encouraging developments in the water resource domain. I begin with the practical examples already referred to above: the Sabarmati Forum in Gujarat, and the dam-oustees movement in Maharashtra. After this I discuss the relevance of the Panchayat Raj institutions to the discussion at hand.

The Sabarmati Basin stakeholder platform[19]

The Sabarmati River Basin stakeholder forum is a case of a civil society initiative to facilitate the emergence of a multi-stakeholder platform for integrated river basin management. The account below covers the period from 1997 to 2001. The initiative was an outcome of the involvement on the NGO VIKSAT (Vikaram Sarabhai Centre for Development Interaction, Ahmedabad) in three different projects in the Sabarmati River basin. These projects were:

1) Water Scarcity and Pollution Problems in Sabarmati River Basin: A Participatory Approach to Water Management in the Basin supported by the Gujarat Ecology Commission under the World Bank's COMNEAF;
2) Local Supply vs. End-use Conservation Management with support from the International Development Research Centre (IDRC), Canada;
3) A pilot project in the Sabarmati River Basin in India run with Indo-French collaboration.

The overall goal of these three projects was to facilitate the emergence of one or more forums of stakeholders, which would enable them to participate in the planning and implementation of water management interventions to address water scarcity and population problems in the Sabarmati River Basin.

The specific objectives of the exercise included the following:

1) To understand the nature and extent of the water scarcity and pollution problems in Sabarmati River Basin and their impact on different stakeholders;
2) To identify technically, socially and economically viable water management interventions (physical and regulatory) for the basin;
3) To identify both the role of stakeholder communities and strategies for facilitating their participation in planning and implementing projects dealing with water management issues in the basin; and
4) To foster participation by facilitating one or more stakeholder forums

As is not uncommon for similar platform or dialogue initiatives elsewhere, a committee called the Steering Committee was formed after some initial groundwork. It was constituted to guide project implementation and was headed by a retired Secretary of the Ministry of Agriculture in the Government of Gujarat. The committee included members from government departments like the Narmada and Water Resource Department, the Gujarat Pollution Control Board, the Ahmedabad Municipal Corporation and the Gujarat Industrial Development Corporation. District development officers (DDOs) of districts falling in the

basin, researchers, academics, and training institutes like the Institute of Rural Management, Anand, the Physical Research Laboratory (PRL), Ahmedabad, and the Gujarat Jalseva Training Institute also participated. Leading industrialists were also included as the members of the committee. VIKSAT was given the responsibility for convening the committee.

The following activities were undertaken by the steering committee: conducting field studies surveying literature, the publishing an information brochure, identifying stakeholder sub-groups in the basin, holding meetings of these sub-groups and of the Steering Committee, formation of the Stakeholder Forum, evolving the future agenda through stakeholder meetings, identifying issues concerning stakeholder sub-groups and inviting possible solutions from them, setting future agenda and convening the Forum meetings**.**

Two Stakeholder Forum meetings were organised and representatives from different stakeholder sub-groups as well as the Steering Committee members attended them. The findings of the water balance modelling carried out under the IDRC-supported project were used as a basis of the discussion in the first meeting, which aimed to finalise the solutions and recommendations suggested by different sub-groups. The second meeting concretised various aspects of the Forum, including its structure, constitution, and role as well as its working strategy for managing the water resources of the basin.

The latest development (2001) was the formation of a Policy Advocacy Cell within the framework of the Stakeholder Forum. This cell was supposed to take up the issues discussed above with concerned agencies in order to reach more democratised and effective solutions. Research in 2004 suggests, however, that the Forum initiative may be stagnating or at best moving ahead very slowly. One issue facing this projects case and other, including one in the Palar Basin in Tamil Nadu which is initiated by NGOs or other civil society actors is how to consolidate and institutionalise after the initial period of enthusiasm and dynamism. The possibilities include state-level policy and bureaucratic reform which allows for more democratic and inclusive policy formulation and implementation as well as the development of a (strong) organisational base in and the mobilisation of the interest groups concerned.[20] The process of consolidation and institutionalisation is illustrated by the second example.

The dam-oustees movement in the Krishna Basin

The dam oustees movement in Southwest Maharashtra is an interesting case because it is exemplifies how mass movements and civil society institutions can together rise against the establishment and force it to accept some of their demands. In this case, stakeholders (the dam affected, dam beneficiaries, local units of political parties and civil society institutions like NGOs) came together to discuss, deliberate and take decisions on water related matters. As the movement progressed, various other stakeholders joined the campaign and towards

the end even the government joined the dialogue. This example can be read as an illustration of how oppositional politics can be transformed into negotiated development.

The roots of this movement can be traced to Uchangi village in the Aajara *taluk* of Kolhapur District. The Maharashtra government planned to construct a dam on the small river Tar-Ohal. In order to impound 660 million ft^3 of water, the reservoir would submerge six villages. The beginning of its construction in 1977 met stiff opposition by thousands of men and women of upstream villages who actively opposed the construction of the dam by the State Irrigation Department. As a result, a meeting of the affected villagers, activists of the Shramik Mukti Dal and district-level officials was organised. An agreement was arrived it at the end of the meeting: to consider a scientifically prepared alternative to the above-mentioned dam. This was the first achievement of the movement.

The NGO 'Society for Promoting Participative Eco-system Management (SOPPECOM)' agreed to prepare this alternative plan under the condition that relevant data would be made generally available. A rough plan was prepared using the data released but in the absence of topographical survey data (which the Irrigation Department, citing the Official Secrets Act did not make available), no concrete alternative plan could be prepared. The rough plan and the demand that the whole matter be discussed with the higher authorities in the Maharashtra Krishna Valley Development Corporation (MKVDC) were rejected by the district authorities. A new attempt to start dam construction in June 1998 met with the same fate because of determined and joint opposition from Chaphavade, Jeur and Chitale villages. Ultimately the district authorities did give the villagers some assurances.

Despite its assurances that it would provide the technical data needed to prepare a concrete alternative plan, the Irrigation Department delayed data for 16 months. Authorities also tried to start dam construction once again, but their attempts were foiled and the government was forced to provide the topo-sheet. Despite the inadequacy of the data an outline of the alternative plan was submitted. It proposed building three smaller dams on the Tar-Ohal River which would have the capacity to impound 624 million ft^3 of water, enough to irrigate the area mentioned in the government plan twice over. The alternative plan suggested that 3,000 m^3 of water be given to each family as per the principle of equitable water for sustainable development. Requirements for additional water, it argued, could be met from the local watershed, thereby ensuring no displacements and limited submergence of good quality land.

The alternative plan was partly accepted. Its provision for two small check dams was approved and the engineers of the MKVDC agreed to reduce the height of the Uchangi dam. The Irrigation Department however, rejected the second site. This rejection was once again questioned by the joint front of the Maharashtra State Dam and Project Oustees' Organisation, Shramik Mukti Dal, village representatives and SOPPECOM experts. Although it was indeed possible to reduce the costs of dam construction by introducing a

different technology, the officials from MKVDC said they were unable to go beyond government norms and techniques.

Since the modified MKVDC plan to reduce the height of the Uchangi dam was not acceptable to the villagers, the government was forced to agree to build a second dam and to ensure that no house would be submerged due to dam construction. An unprecedented victory was the government's promise to provide lift irrigation facilities to dam-affected villagers at its own cost.

The movement for the equitable distribution of dammed water in South Maharashtra, which started as a dam-protest, is now more than a decade old. It has spread to 13 *talukas* in Sangli, Satara and Solapur districts. The Shetmajoor Kashtakari Shetakari Sanghatna, (Landless Labourers and Toiling Peasants Organisation) (SKSS) was led by freedom fighter Nagnath Anna Nayakwadi, Bharat Patankar of Shramik Mukti Dal, and Nana Shyetye of the Lal Nishan Party (L). This movement also received support from local organisations like the Hutatma Kisan Ahir Cooperative Sugar Factory. Some local leaders of leftist political parties have supported the movement, but open support from the party high command has been missing so far.

There is more history to tell, but this short extract suffices to illustrate the main points in the context of this paper.[21] Like the one in the Sabarmati Basin described above, this process now operates (after a localised start) at the basin/sub-basin level. The difference is that the initiative has a strong grounding in social movements. The case also shows that the process of achieving more inclusive water resource planning is a long, and perhaps a never-ending, one. However, it is encouraging that government agencies have been induced to engage in the process. Though the negotiations between the movement and the government have not been formally institutionalised, the capacity to form a broad front and to translate protest into a new approach to water resource development in which the government is enrolled is a significant achievement.[22]

Neither the two cases in Sabarmati nor the one in Maharastra are 'model examples' meeting glorification. Both have contradictions, about which those involved seem well aware. I do believe, however, that, in the Indian context, these cases constitute innovative attempts to address water resource management and planning and contain elements that are essential for overcoming the state/village dichotomy. These elements include the 'grounded' nature of the issue at hand (in development speak, the ownership of the problem), the playing out of different aspects of the problem at the different levels, the (long) time frame of social and institutional transformation, the importance of social organisation and mobilisation, the relevance of an articulated resource and development approach or vision specific to the region, and the vexing issue of consolidating activist energy and achievements into institutional reform.

The Panchayat Raj and decentralised planning

To conclude this section of the paper, I briefly comment on the relevance of the Panchayat Raj amendments to the Indian Constitution for the issues discussed in this paper. An argument for the decentralisation of governance and development planning is clearly implicit in the discussion above. In general terms therefore, these amendments could be of great importance in the water resource domain. In canal irrigation, in particular, I believed that a tiered system of decision-making on administrative and development issues is exactly what is required.

Organising decentralised planning and governance along political-administrative lines may, however, create problems for the management of natural resources. Administrative and hydrological boundaries rarely coincide.[23] This raises the issue of whether separate (functional) organisations should be established for water resource management or whether natural resource governance should be brought under the aegis of political-administrative institutions. Proponents of the PRI amendments seem to be rather keen to bring everything under the political administrative umbrella, probably to strengthen the movement. This may not always be very useful for water resource management.[24]

More important in the context of this paper is that the PRI thrust seems to focus mostly on the village and not on intermediate levels of governance and administration. In his recent book on water resource issues, Iyer makes a similar observation while discussing the constitutional arrangements for water management. He observes that when the Constitution was written, governance was defined at the national and state levels, but not further down and that the PRI amendments have added governance at the village level (see Iyer, 2003). This clearly suggests that the state/village dichotomy is not just an idea, a mental construct, but is in fact, consolidated in legal and other institutional arrangements.

CONCLUSION

To some extent, my general assessment of the prevalence of dichotomous thinking and polarised politics can be countered with a list of examples demonstrating the contrary. The message of this list would be that I was over simplifying reality, that is, there is much more diversity than I suggest. Such examples do exist, no doubt, and they help us to think about innovative approaches. They can also be read as proof of the strength of India's democratic set-up and complement the discussion of the weaknesses I stress in this paper. Nevertheless, the unpleasant fact remains that these initiatives are few and far between and have not translated into a general shift in India's approach to water resource development and management. The technocratic paradigm is still firmly in place, as is the top-down, prescriptive administrative style of governance. This can be seen, for example, in the way watershed development programmes are being implemented by government

agencies. Though the notion of water conservation has been adopted, implementation tends to be as technocratic as it was for earlier government programmes.[25] In the canal irrigation sector, even this headway—of implementing new approaches in an old, technocratic way—has generally not been made.[26]

What I intend to argue in this paper is that even the 'alternative paradigm' side of the debate is generally caught in the same quandary as the old paradigm. This proposition is discussed further in the next section.

A CRITIQUE OF WATER RESOURCE MANAGEMENT DISCOURSE AND PRACTICE

The dichotomies that figure in today's water resources management discourse include modern science *vs.* local knowledge, modern irrigation *vs.* traditional irrigation, macro *vs.* micro, large (-scale) *vs.* small (-scale), government *vs.* village, global *vs.* local, and market dependence *vs.* subsistence. All are associated with the all-encompassing dichotomy bad *vs.* good or *vice versa*.

Dichotomies are not only conceptually inadequate,[27] but, in the view of this author, also politically paralysing. They lead to polarised positions that destroy creativity and the possibility of negotiating outcomes. I hope to suggest that there are other avenues that provide more promising, and more realistic, starting points for water resource development. To begin, though, we need to explore the reasons many people remain caught up in dichotomies and polarisations.

This is perhaps easiest to understand for the water resource establishment where huge vested interests, at the institutional as well as the personal level are widespread. Contracts and corruption are part of this equation, but so is the technocratic mindset. There is a whole institutional structure geared, both technically and institutionally, to supply-oriented approaches. India's canal systems are designed technically as supply-oriented systems and management structures are correspondingly centralised. A high-tech orientation has become the professional standard, and there are no incentives for the laborious work of field level engineering. A proud history of engineers becoming statesmen is another factor. The legendary M. Visvesvaraya is a prime example. Many older engineers utter sentences like 'since democracy came, things have become worse' when interviewed on these matters. This dislike of democracy reflects the decreasing status of the engineering profession and political interference in the engineer's day-to-day work. The latter must be acknowledged as a real problem. In addition, many engineers genuinely feel that their professional expertise and achievements are ridiculed by 'environmentalists and sociologists', some of whose alternatives presented seem to them rather unrealistic or outright flawed.

On the NGO/civil society side, the predilection for a bi-polar worldview is not as easy to understand. I, very tentatively, identify the following explanation.

In the 'localocratic' perspective, a translation takes place from a *concern* for local people who suffer deprivation in various forms, to a *strategy* that says that action should start and focus at this level. This perspective has a strong Gandhian and 'village republics' current in that village-based subsistence economy is seen as the alternative development paradigm. Even though the extreme form of this view is not often adhered to, it still seems to be present in a lot of thinking and practice. To this author, the view seems to deny of not only ground realities and the existing dynamics of social (urban and rural) transformation but also the legitimate aspirations of people living in villages.

Another influential notion is that if there is to be a sustainable ecological future people will have to make do with the water that is available in their locality. This view suggests that water resource issues can and should be resolved *in situ*. It works as long as there is enough water to be conserved and local conservation does not affect others outside the locality. However, as is suggested above, trends in agricultural intensification aimed at increasing living standards and population increase are likely, in many cases tend to make this impossible. At the level of principle, this author sees no basic reason why people who happen to live in areas well endowed with water should not share with those who, equally fortuitously live in less well-endowed ones. As a counterpoint to megalomanic water transfer projects, the 'live-with-the-water-you-have' argument needs to be appreciated;[28] reifying it into an absolute principle does not, however, seem very helpful.

It is my distinct feeling that many NGOs active in the water sector would rather have nothing to do with government in terms of trying to shape its functioning but would instead prefer to focus exclusively on their own local projects.[29] Governments are mostly seen as either a constraint or a source of funds, something to lambaste or something to propitiate. The long march through bureaucratic institutions is not popular among development activists, possibly because it can be an extremely frustrating exercise. At the same time, scaling up local initiatives often requires an 'enabling environment' and 'the political will.' Where this support should come from is a question not often seriously asked.

In this respect the establishment of WUAs in canal irrigation systems can serve as an example. Such local efforts will thrive only on a limited scale as long as overall system management and irrigation policies are not reviewed.[30] Because of the intimate physical connection between the micro and the macro in the case of large canal systems, it is perhaps more difficult to find niches for successful local development in such systems than it is in the case of water conservation or forestry-centred initiatives. The nature of the resource and the technology needed to use it thus render the desire to confine oneself to local-level activities a fruitless one.

On the radical left there seems to be a certain unwillingness to or lack of interest in addressing problems associated with the 'developmental state' perspective. The resistance to deregulation and liberalisation (as laid out in anti-privatisation and anti-globalisation critiques) seems to have led to an avoidance of an upfront acknowledgement of the problems which exist in the functioning of state apparatuses. It seems difficult to on the one hand, defend the state as a key actor in the development process and, on the other scathingly criticise bureaucratic functioning. The dominant approach still seems to be to analyse the issue as a matter of bringing the correct (that is the leftist) political party into power, and thereby, automatically getting the state to perform better. Whatever the exact position on and background of the noted unwillingness or lack of interest may be, it directs debate away from struggles within the state and the details of the state's internal structure and modes of interaction with society, and, therefore, away from the issue of bureaucratic reform.[31]

The above discussion identifies three reasons behind the persistence of a bi-polar worldview among proponents of alternative development paradigms.

1) The concept of local, autonomous development is central to the alternative development trajectory;
2) Water resource development and management is assumed to have to 'make out' with the water available *in situ*;
3) Non-engagement with transformation of existing state apparatuses, for varying reasons.

To be transformed from a simple criticism into a critique, this argument also has to identify the conditions that explain the persistence of this set of perspectives. The material base for dichotomous views and polarised politics is the concrete existence of a highly divided, bi-polar *practice* of water resource management, as noted in the discussion of the findings of the inventory of multi-stakeholder platforms above. As noted, the state/village dichotomy is enshrined in the Constitution in the sense that intermediate levels of governance are poorly if at all defined. This is not a 'design error,' but a situation rooted in the long and complex history of both the state and the village sides of the relationship, as well as a structural characteristic of India's political democracy (see Kaviraj, 1997).

Two elements I extract from Kaviraj's analysis are firstly the 'imposed' (but irreversible) character of parliamentary democracy, leading to an 'external' relation between the state and local communities and social groupings in general; and, secondly, the role of caste in the reproduction of this relation. The Western form of political democracy that India adopted after independence was an elite project implanted on Indian society 'from the top' and not a system whose design emerged out of local struggles. The political and administrative institutions of the state have, as a result, in some respects been treated by

people in the same way as they treated the colonial and pre-modern states. Touting redistributive rhetoric post-independence emancipation and economic development allowed new groups, to access state resources. In this structure, with the state exterior to local social dynamics, the state is seen as a whimsical tyrant with which one enters into relations of patronage but never considers as one's own. It is seen as an entity whose behaviour one tries to control or influence for one's own benefit. As Kaviraj eloquently shows this attitude can trace its historical roots to the way the pre-modern and colonial states operated. Moreover, independent India decided to adopt the British system of colonial administration. In the, period of political instability after independence, the new leadership found that a 'strong state' needed to be established.

Regarding caste, Kaviraj, about pre-modern states in India, argues the following position.

> "[p]ower at the level of the village community tended to be exercised through the paradoxical logic of the caste system. Its specific manner of allocating productive functions and rewards maintained a system of social repression without making specific individuals the agents of these relationships of disdain and resentment. The global human world, its essential principles of ordering, were not subject to individual or collective construction. (…) The political implication of this feature of caste society is important. Under this arrangement, it is impossible for the state to aspire to become the site of universality and sovereignty; the state could not claim a Durkheimian majesty by becoming the symbol of society as a whole, and a preserver of its form and continuity. That was lodged in a self-maintaining moral; order to which the state was normally subordinated. (…) [The state's] primary function was to police possible infringements, not to make rules affecting the fundamental order of social relations. (…) Thus, the precolonial type of political authority seems strikingly devoid of two features that social struggles of European modernity imparted to the modern state. It was not an authority for appeal against widespread structural injustice, oppressions, iniquities, irrationalities of social processes. (…) To apply the state/civil society distinction to traditional India therefore would be to invite a serious conceptual misunderstanding." (*Ibid*)

There is now a civil society in India, and a very active one as demonstrated above, so there a simple argument of continuity will not hold. However, the (central) state-village dichotomy still seems to be very much part of the Indian polity, and the state has not achieved the dissolution of caste-based relations of domination, even though it has tried. The existence of a strong caste-hierarchy as a general organising principle implies the lack of vertical solidarities, and thus predisposes discourse and practice to bipolar forms.

A mechanism, which operates at the day-to-day level of the practical mechanics of polarisation, is as follows. It is often strategically convenient to phrase issues and approaches in bi-polar terms (and inconvenient to emphasise complexity and diversity). To engage with the system, one cannot ask fundamental questions and look for nuances all the time. Some closure and simplification is necessary for effective strategic action. These strategic counterpoints however, tend to solidify into paradigmatic categories which are seemingly confirmed by day-to-day experience where government administration is not accountable and where politics focuses on gaining concessions from the state for and by social groups, often caste-based.

The Indian paradox of the existence of an institutional gap between 'government' and 'village' in an overall democratic set-up can perhaps be resolved in the following manner. Since Independence, through the gradual emancipation of the so-called lower castes and classes the principle of hierarchy has increasingly been questioned. This process has required, and still requires, a lot of confrontational politics to advance. This struggle has primarily focused, as far as the institutions for resource management are concerned, on *access* to existing (state) apparatuses and programmes rather than on questioning the apparatuses and programme themselves.

The adoption of the 73rd constitutional amendment in 1993 to strengthen the Panchayat Raj system perhaps signifies that it is now possible to reconsider the characteristics of some of these (state) apparatuses and programmes. Through this amendment, decision-making has been both democratised and decentralised and now can become more inclusive. This is thus a focus on the *process* dimension of, in the context of this paper, resource management. It implies a shift from a focus on equity to an enlarged scope that also looks at the institutional mechanisms through which equity and other aspects of development can be *negotiated* by the interest groups concerned. The PRI effort may, however, reproduce the same village-state dichotomy through its strong focus on village institutions and their legitimisation by state governments. Moreover, the type of decision-making possible in PRI institutions may not be appropriate for adequate natural resource governance and management and may not be able to deal effectively with the issues at different levels. In short, the PRI framework doesn't take the issue of institutional reform far enough. The discourse and practice of institutional reform in the water resource sector, as elsewhere, is still caught in the state-village dichotomy.

IMPLICATIONS FOR RESEARCH AND PRAXIS

The implications of the argument above for water resource research and praxis are discussed below.

Regarding research on *institutions* for water resource management, more attention should be given to the study of these institutions at different levels. In addition to examining

negotiated development at the local level, efforts to investigate the establishment and functioning of institutions at higher levels is important. Advocacy and research on the problems of the Tribunals and on alternatives to that framework is also relevant. More generally, research and advocacy on how water users and organisations representing them can participate in water resource policy formulation rather than only implementation is another topic of academic as well as practical interest.[32]

On the front of *science and technology,* there is a strong need for what I would call 'creative engineering' or 'innovative knowledge generation and management,' that is, the (re-)invention of a water science that directly engages with real world water problems in a comprehensive manner. This would have to be done through the collaboration of water professionals, in 'conventional' disciplines, water users, and academic or other facilitators that know the ropes of interdisciplinary research and development practice. Such participatory approaches have already been developed in sectors other than the water sector; canal irrigation however, is the most barren terrain.

In the field of *development practice,* I would call for larger-scale experiments with the more comprehensive alternative paradigms that were discussed above by supporting existing local and regional initiatives.

For all these desirable actions both the emerging international bandwagon and the container concept of integrated water resource management (IWRM) may prove to be useful.[33] These developments may provide policy and discursive space to advocate, strengthen and initiate new approaches in research, capacity building and praxis. But buying into this global process implies, for some, committing the adulterous act of sleeping with the enemy. Luckily, people, and not metaphors, manage water.

NOTES

[1] Perhaps illustrative of this lack of debate is that in the *Social Ecology* collection edited by R. Guha (1998), the paper selected on this topic written by Whitcombe refers to the situation in the 19th century. In recent times scores of activist writings have highlighted the ills brought by large-scale waterlogging in the command of North-Ganga plain, but they are not part of the larger debate. See Gyawali (1998) for analysis.

[2] For example, the analysis of 'the system of political and administrative corruption' initiated by Robert Wade (see Wade, 1982) has not been taken forward. The equity issue that was prevalent in policy debates on canal irrigation in the 1970s and 1980s has attracted little attention from scholars in the past decade. The discussion and practice of establishing WUAs has not been developed into a debate on democracy in local resource management. The general point here is that social science analysis of *canal* irrigation has never really taken off in India. A predilection for the local and the village exists in social science scholarship. Most critical scholarship has focused on local, farmer-managed irrigation and other local forms of water resource management. For example, the historical literature on canal irrigation is a fraction of what is found on tank

irrigation. Apart from the feel-good factor in studying local processes, social science seems to fear studying large technical systems, because such studies supposedly require a lot of technical expertise. In addition, a strong tradition of studying state practices, that is, social anthropological investigations of the politics of policy formulation and implementation is lacking.

[3] Other factors beyond the scope of this paper also play a role in explaining the defensiveness of the water bureaucracy, particularly those relating to 1) the budgetary crisis many state governments face which exerts pressure on irrigation department budgets and 2) performance and management problems within systems. At the level of discourse and perspective, however, the debate about large dams has strongly shaped the attitudes of the engineering establishment. This has led to aggressive organised lobbying for the pro-dam stance.

[4] It is probably correct to say that the environmentalist perspective has triggered innovation in the water sector in many places in the world, not just in India. For example, in the Netherlands, the transformation of water boards from farmer controlled and agriculture oriented organisations into multi-stakeholder bodies dealing with water in a more comprehensive manner was mainly triggered by environmental criticisms of agricultural water use. For how the USBR (United States Bureau of Reclamation, the American irrigation and dam agency) internalised environmental concerns, see Espeland (1997). Its approach is also briefly discussed below.

[5] See, for example, Nadkarni (1984), Dhawan (1988) and Chambers (1994).

[6] See Shashidaran (2000) on this issue. The reasons he identifies for the lack of NGO interest in canal irrigation are fear that irrigation will further increase the divide between the haves and the have-nots, that it will lead to unsuitable agricultural practices and is inherently environmentally unsound, that it is 'high tech' and beyond the scope of NGOs/CSOs, and that NGOs/CSOs do not relish the prospect of having to interface with government departments.

[7] It can be argued though, that in many areas the combination of canal irrigation and private tubewell irrigation has been the core trigger of agricultural intensification since the introduction of the Green Revolution crop varieties and related inputs. Private (tube) well irrigation has expanded explosively (see Dhawan, 1982) within and outside canal irrigation command areas.

[8] As with waterlogging and salinity, it is hard to find reliable statistics, but case study evidence suggests that the areas involved are substantial. The Development Support Centre, Ahmedabad, and Wageningen University started a research project in October 2001 on 'tailenders and other deprived' farmers in different types of irrigation systems across India that is intended to provide a slightly better approximation of the magnitude of the problem. The report, which was published in 2003, shows very substantial areas of deprivation in canal irrigation (see planningcommission.nic.in/ reports/sereport/ser/std_prbirrg.pdf for the final report of the study; also see Rajagopal *et al.*, 2002))

[9] For a discussion of the village-state dichotomy in natural resource management analysis and practice (particularly forestry/joint forest management) that also refers to the 'small is beautiful' trajectory of natural resource management activism and research, see Lele (2003)

[10] One effect of the large dam controversy (and other factors) is more attention on land and water management in rain-fed regions in general and in rainwater harvesting in particular (see the *Introduction* in Agarwal and Narain, 1997, where this connection is stated). This is very welcome and long due, but separate programmes for such issues tend to reproduce the dichotomy discussed (even when the strengths of the dichotomy's poles may have become less unbalanced).

[11] This is not to subscribe uncritically to the 'ecological modernisation' paradigm, but simply to show that environmental concerns have been internalised to some extent. Arguably, in general, state bureaucracies are less prone to generate processes of reform through 'social learning' than some parts of the corporate sector given the incentives and structural features in/of the two domains. I do suggest, however, that the Indian situation with regard to water resources reform

is not adequately explained by general 'bureaucratic inertia' arguments.

[12] The institutions could be 'formal' or 'informal', that is, not many restrictions on what they should look like to qualify as a multi-stakeholder platform were put. The objective of the inventory was exactly to find out what form such institutions do take in practice.

[13] A point not explored extensively in this paper is that there may be strong political and historical roots to this state-village dichotomy. On this see Kaviraj (1997) Gandhian thought is also important in this context.

[14] Consider the following 'only way' construct in the Executive Summary of Agarwal and Narain (1999). I have no problem in agreeing to a large extent with the substantive part of the account, but the strategic inference in the last paragraph is, in my view, highly debatable.

"[The] tradition of [rainwater harvesting], and the knowledge and management systems which accompanied it, has been undermined by two recent changes, largely brought about by colonial attitudes to water management and administration:

1) The state has become the major provider of water, replacing communities and households as the primary units for provision and management of water.

2) There has been increasing emphasis on the use of surface and groundwater, while the earlier reliance on rainwater and floodwater has declined, even though rainwater and floodwater are available in much greater abundance.

However, a number of recent initiatives, both community and government driven, demonstrate that reviving rainwater harvesting systems can dramatically restore ecosystems and contribute to rural development. But the success of these cases does not just depend on the development of rainwater harvesting structures; the entire exercise must be underpinned by community-based decision-making systems and institutions, and enabling legal and financial measures which promote community action.

The *only way* this objective can be achieved is by deepening systems of participatory democracy and expanding people's participation at the *village-level* as much as possible. Every settlement must have a clearly and legally defined environment to protect, care for and use, and an open forum in which all can get together to discuss their problems and find common solutions. By strengthening and emphasising the importance of open forums, common solutions and common natural resources, the developing world can make a determined bid to revive the dying community spirit and to rebuild its devastated environment."

[15] In all fairness it must be said that NGOs do recognise the problem to some extent. For example the problems related to the sinking of tubewells in tank commands areas is a well acknowledged issue, and there is a discussion on the conversion of irrigation tanks to percolation tanks. Venkateshwarlu and Srinivas (2001) report that in Andhra Pradesh in several instances tank users have restricted command area farmers from pumping borewell water to non-command areas. However, this does not address the problem fully, as tanks also recharge groundwater outside the command areas, and to avoid over-extraction this pumping would also have to be regulated. This takes the issue from the tank level to the supra-tank level. The referred report does not discuss this. The tank remains the unit of analysis. I am not suggesting that there care no individuals with this insight. The point is that the issue is not part of the policy and public discourse.

[16] For a discussion of Tribunals and the Cauvery issue, see for example Iyer (2003).

[17] This is not the place to go into questions like how these colonial traditions made or not made use of existing available irrigation knowledge. Local knowledge was both incorporated and suppressed, though this is rather poorly documented. One aspect of this is that Indian/sub-continental irrigation knowledge seems to have been much less codified than for example Chinese irrigation knowledge. It seems to have existed primarily in the form of skilled labour power. The regional imperial

traditions also made contributions to general hydrological and engineering science. The early decades of the 20th century were a period of rapid development of these disciplines.

[18] See Nanda (1991) for a critique of criticisms of green revolution technologies.

[19] This section and the next are extracted from a draft report by Rajput (2001) The Maharashtra case description within this is mainly based on Phadke (2000).

[20] The case will be analysed in more detail in the PhD thesis of Sriprakashsingh Rajput, whose initial report was used for this discussion (see previous footnote).

[21] Regarding more detailed analysis, the same applies to this case as mentioned in the previous footnote.

[22] On the concept of 'regenerative agriculture' underlying some of the conceptual thinking in the initiative, see Paranjape and Joy (1995) and Datye (1997).

[23] The issue of boundaries is more complex than a mismatch between administrative and hydrological boundaries, and doesn't exhaust the problematic of institutional integration or coordination, but detailed discussion is outside the scope of this paper. Moss, in the European context, classifies the issues involved as those of fit, scale and interplay (Moss, 2003).

[24] Irrigated farmers in Andhra Pradesh have in 2004 protested against plans of the new Congress government in that state to bring WUAs under the PRI, and they seem to have been successful (personal communication with R. Doraiswamy of *Jalaspandana*).

[25] Another example of how firmly the 'old paradigm' is still in place, is the surge of the Interlinking of Rivers idea after the Supreme Court order about this.

[26] Some qualification is necessary here. Efforts by governments at the introduction of farmers' participation through Water Users Associations have generally been top-down (in contrast to some NGO initiatives). More importantly, they have been very piecemeal. The introduction by the government of Participatory Irrigation Management in Andhra Pradesh, since 1996-97, on a very large-scale seemed to signal a new phase in irrigation reform. However, it has not taken on board ideas on integrated water resources management, ecological sustainability and water rights for example. It is very much a product of the 'irrigation management' perspective on irrigation. It does introduce tiered decision-making with user involvement, at minor, distributary and project level. The Project Committees are yet to be established, however, which reinforces the argument of this paper.

[27] For almost any topic and discipline critiques of dichotomous conceptions are available. For a general discussion of dichotomies in social science analysis see Krieken (2002).

[28] Regarding excess water in flood prone areas there is a similar 'living with floods' argument. See Ahmed (1999).

[29] For example, there are no examples known to me of NGOs/CSOs specifically focusing on accountability, participatory budgeting or right to information issues, at least in rural water management, and certainly not in canal irrigation. Such concepts seem to be more promoted in urban areas and other sectors.

[30] As the cases of Maharashtra and Gujarat illustrate. When Andhra Pradesh government officials designed their irrigation reform policy in 1996-97, they deliberated that if they would go by the NGO approach to irrigation reform they would never get there, and settled on a State–wide introduction by means of an Act.

[31] Put differently, my suggestion is that radical leftist approaches focus on the classical Marxist concerns of state power, class domination and imperialism while discussing the state (and designing political strategy), and are less interested in the details of its internal organisation and state projects and practices. This phrasing is taken from Jessop (1990: chapter 12). In

Indian social science this has led to a relative lack of critical research on the internal dynamics of the state and government bureaucracy, including the analysis of policy processes (see Mollinga (2004) for more discussion of this point). Movements for electoral reform and right to information campaigns are counter examples, but they are not very prevalent in water resources activism specifically.

[32] In the context of canal irrigation management this could be phrased as the need to move on from participatory irrigation *management* to participatory irrigation *governance*. The non-establishment of the Project Committees in the Andhra Pradesh irrigation reform scenario would from this perspective be analysed as its main failure: it is exactly where governance power is located, for instance in the allocation of and rule making for water (management) and allocation of and rule making for physical works (execution).

[33] The main global social carrier of the IWRM concept in past years has been the Global Water Partnership, based in Stockholm. The concept is increasingly incorporated in water resources policies worldwide, including India's National Water Policy.

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INCENTIVES IN WATER MANAGEMENT REFORM: CASE STUDY IN THE YELLOW RIVER BASIN

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ABSTRACT

The paper which aims to better understand water management reform in China's rural communities, especially focusing on the effect that improving incentives to water managers will have on the nation's water resources and the welfare of the rural population, has three objectives. First, we track the evolution of water management reform and seek to identify the incentive mechanisms that encourage water managers to use water more efficiently. Second, we identify the impact of the incentives provided to water managers on crop water use. Then we explore how changes in incentives also affect agricultural production, farmer income and poverty status. The analysis demonstrated that it is not the nominal implementation of the reform that matters: rather, it is the creation of new management institutions that offer water managers monetary incentives which lead to water savings. Significantly, given China's concerns about national food production and poverty alleviation, the reductions in water, at least in our sample sites, did not lead to reductions in either production or income and did not increase the incidence of poverty.

INTRODUCTION

China faces many challenges in managing its water, which have serious consequences for the country's economic development. The Government of China has identified the nation's rising water scarcity as one of the key problems that must be solved if it is to meet its national development plan in the coming years (Zhang, 2001). Shortages of water are attenuating efforts to alleviate poverty and are becoming a major source of environmental problems (World Bank, 1998; Zhang, 2000). In many regions of China, rapidly growing industries and an expanding, increasingly wealthy urban population out compete the nation's farmers and agriculture for limited water resources, threatening to curtail growth in food production.

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Facing increasing water shortages, leaders of China debate about which of several approaches they should use to address water scarcity problems, although no option has proved very successful (Lohmar *et al.*, 2003). Developing more water resources to increase water supply has historically been given the highest priority in resolving shortages of water. Since the 1950s, China's governments have invested more than US $ 100 billion into constructing infrastructure for developing new water resources (Wang, 2000). Recently, the State Council of China has announced plans to allocate more than US $ 50 billion for the construction of a project to move water from the Yangtse River Valley to north China. Despite such ambitious goals, the high cost of developing new sources of water implies that the volume of additional water that can be supplied to north China will be marginal. Chinese leaders have also promoted water saving technologies and considered whether or not they should use water pricing policy for management (Chen, 2002; Rosegrant and Cai, 2002). Unfortunately, most of their efforts to encourage the use of water saving technologies, such as drip and sprinkler methods, have failed and, in the past several years, the Ministry of Water Resources has distanced itself from a water policy based on water-saving technology (Zai, 2002). At the same time, political considerations will most likely prevent leaders from moving too aggressively on raising prices, at least in the agricultural sector (Rosegrant and Cai, 2002). So, how does one move ahead?

The current leadership in China has resolved to push water management reform. However, there is considerable debate about the appropriateness of such measures. Experiences of many other countries show that institutional arrangements for water management are important measures for dealing with water shortages (World Bank, 1993; IWMI and FAO, 1995). Since the 1980s, many developing countries have begun to transfer irrigation management responsibilities from the government department to farmer organisations or other private entities in order to mitigate the financial burden of managing irrigation projects and to improve the efficiency of use (Vermillion, 1997). Theoretically, management reform is supposed to rely on increased participation by farmers and better incentives for managers to focus on regulation to improve access to water and increase water use efficiency at the systemic level. Unfortunately, past efforts to implement local water management reforms have not lived up to expectations; many efforts have failed or generated negative influences (Easter and Hearne, 1993; Vermillion, 1997; Groenfeldt and Svendsen, 2000). The most important reasons for the failure of the water management reforms may be embedded in the notion of collective actions, lack of access to information and the failure to get the incentives right.

In fact, in China, policy makers have promoted water management reform since the late 1990s. The outcome of these reforms shows mixed results although most evaluations are based on anecdotes or limited case studies (Nian, 2001; Huang, 2001; China Irrigation Association, 2002). Even in those cases where management reform has

been well-designed, effective implementation has been difficult (Ma, 2001; Management Authority of Shaoshan Irrigation District, 2002). Field visits to such areas can easily show how local water management initiative were begun but failed.

There are many similarities between international experiences and those of China, even in this early phase of reform. In one sense China's water management reform strategy has some unique characteristics. For example, water officials have emphasised the role of incentives in management reform, wherein water managers are provided with monetary rewards if they can meet certain targets, such as achieving water saving. While this initiative is welcome, farmers' efforts to participate in the management of the irrigation system is less encouraging. The prominence given to incentives in management reform in developing countries may be unique internationally but it is not new in the context of China's overall economic reform efforts. Reformers have frequently relied on incentives to induce agents to put in more effort, allocate resources more efficiently and enter into new economic activities (Naughton, 1995). The household responsibility system, for example, primarily gave incentives to farmers in crop production (Lin, 1992). On the other hand, the fiscal reforms gave local leaders incentives to begin township and village enterprises (Walder, 1995).

Another initiative is the grain reforms, which has given grain bureau personnel the incentive to commercialise commodity trading (Rozelle *et al.,* 2000). Clearly, high-level water officials hope that a similar set of reforms can improve the performance of China's water management. While such a strategy may encourage water managers to improve efficiency of irrigation systems, in case of water management there are number of other issues that may potentially create negative externalities. Since the reforms provide financial incentives to the manager to manage water more efficiently, it is possible that they could take a number of actions that could negatively affect production, income and the poverty status of certain individuals or families. For example, managers could deliver less water than demanded by the farmers or cut off deliveries of water to poorer households who are unable to pay or pay slowly. Surprisingly, despite the high stakes in the reforms, there is little or no empirical evidence to judge if water management reform has been effective. This study shows how incentives have been used in irrigated villages in China's Yellow River Basin and focuses on the effect that such incentive may have on the nation's water resources, agricultural production and rural incomes.

DATA SOURCES

The data for this study comes from a survey conducted in 51 villages in four irrigation districts (IDs) in Ningxia and Henan provinces. To increase the variation among regions, provinces located in the upper (Ningxia) and lower reaches (Henan) of the Yellow River Basin (YRB) were chosen. In selecting the irrigation districts, the study chose two upstream

and downstream districts in the provinces based on water availability. After the IDs were selected using the census of villages as a basis, we randomly chose sample villages in the upper, middle and lower reaches of the canals within the IDs,[1] and four households within each village for survey. After obtaining basic information about each plot, the enumerators chose two plots from each household for a more detailed investigation. We surveyed 51 villages leaders, 56 water managers, 189 farm households and gathered information on 378 plots.

In order to meet the study's objectives, we designed three separate survey instruments: for farmers, for canal managers and for village leaders. Three types of water management institutions were identified: collective management, Water User Associations (WUAs) and contracting. In the study villages, we recorded the share of canals within the village covered by each management type for each of three years (1990, 1995 and 2001). In addition, enumerators also asked how managers were compensated. When managers have rights to earnings from water management activities (i.e. to the value of the water saved by management reform), we say that they face strong incentives (or henceforth, merely with incentives). If the incomes from their water management duties are not connected to water savings, they are said to be without incentives.

The surveyors also collected information that helped us develop measures to assess effects of reform: water use, production and income. In order to get relatively accurate measures of water use, which in surface water systems is typically difficult, we adopted the strategy of asking all of those that were involved in the irrigation scheme (farmers, water managers and village leaders) about crop water use in a number of different ways: per irrigation basis, number of irrigation per crop, number of households per irrigation, average depth of water, etc. With this information, we were able to combine various measures into a single measure on which we could develop final estimation of water use (see annex A).

We systematically collected information on income and crop production by plot and crop for all cropping seasons of the year 2001. Income is an estimate of each household's full net income and includes all major sources of income of the household, including that from cropping, livestock, farm wage labour, earnings from a family's business enterprise, and other miscellaneous sources. With information on income, we were able to construct a measure of poverty status by comparing household per capita income (dividing total household income by the number of family members, which include the household head, his/her spouse and individuals that lived in the household for at least three months in one year) with the national poverty line (625 yuan per capita per year in 2001)

The surveyors also collected information about other important variables that we believed affected either water management institutions, outcomes or both. For example, we asked village leaders and water managers if upper-level government officials took steps

to encourage the extension of reform in their villages. Other questions related to the degree of water scarcity, the level of investment in the village's irrigation system over the past 20 years, as well as number of other villages, household and plot characteristics. The details are shown in annex B.

REFORM AND THE EVOLUTION OF WATER MANAGEMENT

With higher-level officials implementing the reforms, surface water is managed in three ways as the field surveys showed. If the leadership through the village committee directly takes responsibility for allocating water, canal operation and maintenance (O & M) and fee collection, the village's irrigation systems is said to be run by collective management. This system has essentially allocated water in most of China's villages during the Peoples' Republic period. Another manner is through the WUA, which is theoretically a farmer-based, participatory organisation set up to manage the irrigation water in the village. In the WUAs, a member-elected board is responsible for the control rights over the village's water. A third system is contracting in which the village leadership establishes a contract with an individual to manage the village's canal networks.

The data collected showed that since the early 1990s and especially after 1995, reform has successively established WUAs and contracting have replaced collective management (table 1). The share of collective management declined from 91 per cent in 1990 to 64 per cent in 2001 (column 5). Across the sample, contracting developed more

TABLE 1
SURFACE WATER MANAGEMENT IN THE SAMPLE VILLAGES IN THE SAMPLE IRRIGATION DISTRICTS (IDS) IN CHINA, 1990-2001

	Ningxia		Henan		
	ID-1	ID-2	ID-1	ID-2	Total (per cent)
1990					
Collective	100	81	100	100	91
WUA	0	5	0	0	3
Contracting	0	14	0	0	6
1995					
Collective	100	72	100	100	87
WUA	0	10	0	0	6
Contracting	0	18	0	0	7
2001					
Collective	27	51	92	100	64
WUA	50	14	0	0	14
Contracting	23	35	8	0	22

Source: Author's survey

rapidly than WUAs. By 2001, 22 per cent of villages managed their water under a contracting arrangement while 14 per cent managed it through WUAs. Assuming that the sample results reflect the more general trends across north China, the somewhat more rapid emergence of contracting may be due to the ease with which systems were set up similar to the other reforms that have unfolded in rural China (Nyberg and Rozelle, 1999).[2]

While there has been a shift from collective management to WUAs and contracting during the past 5 years, water management reform still varies across the four sample IDs. WUAs and contracting arrangement have developed more rapidly in Ningxia than in Henan (table 1). For example, in 1995 the collective ran 100 per cent of the water management institutions in one of the Ningxia IDs (column 1). By 2001, however, only in 27 per cent of the sample villages did the collective manage the water. About 23 per cent was WUA-managed, which was almost the same as those under collective management (column 2). In contrast, significantly less reform occurred in Henan. Only eight per cent of the villages in one of the sample IDs and none in the other had moved to either contracting or WUAs by 2001 (columns 3 and 4).

Although some of the differences in water management among the IDs may be due to characteristics of the villages and local water management initiatives, the dramatic differences between Ningxia and Henan provinces suggest that higher-level government policy may be playing an important role. In 2000, in order to promote reform, Ningxia's provincial water officials issued several documents that encouraged localities to proceed with water management reform (Wang, 2002). The regional water officials expanded considerable effort to promote management reform in a number of experimental areas. The sharp shift away from collective management is consistent with an interpretation that these measures were effective in pushing (or at least relaxed the constraints that were holding back) reform.

The differences among the villages in Ningxia and variations in the way that different regions implemented the reforms (i.e. some moved to contracting while others shifted to WUAs), however, show that the reform processes are far from universal. In fact, this is what would be expected in China, a nation that often allows local governments considerable room in making their own decisions on the form and timing of institutional changes (Jin, Qian and Weingast, 2000). In contrast, neither the Henan provincial government nor any of the prefecture governments have issued directives mandating reforms.

VARIATION IN GOVERNANCE OF VARIOUS WATER MANAGEMENT FORMS

While the shift in China's water management institutions demonstrates that the nation's communities are following policy directives developed and issued from higher-level

governments, local leaders set up their organisational frameworks in their villages, showing that the practice often varies from theory. For example, at least in the early stages of the development of WUAs (the stage of the organisations that we observed since this type of management is new), the organisation of most WUAs is different from theory. In the case of ninety per cent of the WUAs, the governing board of the WUA was the village leadership itself. In a minority cases (30 per cent of the WUAs), village leaders appointed a chair or manager to carry out the day-to-day duties of WUAs. In WUAs that had village-appointed leaders, however, the manager actually had close ties to the village leadership: more than half were leaders in an earlier period. In other words, this meant that, at least in terms of the composition of the management team, most WUAs differed little from collective management. Furthermore, in reality, farmers had little voice in managing or appointing the management team in their community's irrigation system. Although 80 per cent of WUAs hold regular meetings, only 30 per cent of them invite farmers to participate. Even in the villages that invited farmers to participate, on average, only five per cent of those that attended management meetings were farmer representatives.

An examination of the way that managers are compensated perhaps showed the greatest difference between theory and practice. To understand this, however, we need to understand how farmers pay fees, managers are compensated and how payment is given to IDs. In fact, water management reform has created a complicated system of fees, payments and changes that embody the primary incentives for the managers to save water. Water fees collected from farmers include two parts: basic water fees associated with the fixed quantity of land in the village and volumetric water fees associated with the amount of water used. Set by the water bureau officials, a farmer is required to pay the basic water fee (based on his land holdings) and part of the basic water fee belongs to the water manager after it is collected. This part of the manager's compensation is paid to him as a fixed payment and provides little or no direct incentives to save water.[3]

Higher-level officials, however, can use the other part of the water fee to provide managers with more direct incentives. Prior to the farming year, ID officials determine (on the basis of historic use patterns and other criteria) a targeted amount of water that a village should use (called the target quantity). Based on a per cubic meter charge, the total value of the expected water use for the village is then divided by the village's total amount of land and the volumetric fee added to the basic water fee provides a farmer no incentives to save water since he/she pays a fixed fee for each hectare of land. The water manager in some communities, in contrast, does have an incentive to save water. In implementing water management reform, ID officials agree that the manager only has to pay the per cubic meter charge for the water that is actually used (actual quantity). If the actual quantity of water delivered to the village (at the request of the water manager) is less than the targeted quantity, the difference between the volumetric fee that is collected

from the farmers and that which he pays for the water is his excess profit. In communities that give the water manager full incentive, the excess profit is an amount that is earned by the manager beyond the fixed payment.

Our study showed that there are sharp differences in the way villages have implemented the incentives part of the reform packages, regardless of whether they are WUAs or contracting arrangements (table 2). For example, in 2001, on average, leaders in only 41 per cent of villages offered WUAs and contracting (or non-collective) managers with incentives that could be expected to induce managers to exert effort to save water in order to earn an excess profit (row 1). In the rest of the villages, although there was a nominal shift in the institution type (that is leaders claimed that they were implementing WUAs or contracting), in fact, from an incentive point of view, the WUA and contracting managers faced no incentives (row 1). In these villages, water managers are like village leaders in a collectively managed system in which they have no financial incentives to save water. The incentives offered to the managers, however, differ across IDs (rows 2 to 6). Hence, to the extent that incentives are the most important parts of the reform, the differences across time and space mean that it would not be surprising if in some villages WUAs and contracting were more effective at saving water than in others.

Somewhat ironically, since one of the main goals of water management reform is to provide farmers with better irrigation services, the design of the water management reforms placed little emphasis on the incentives for farmers. In many villages, the water management reforms at most, mandated that water fees paid by farmers should be reduced.

TABLE 2
INCENTIVES PROVIDED TO WATER MANAGERS IN WUA AND CONTRACTORS IN THE SAMPLE IRRIGATION DISTRICTS (IDS) IN CHINA, 2001

	Percentage of samples (%)		
	With incentives	Without incentives	Total
Whole sample			
WUA and Contracting	41	59	100
Ningxia Province			
ID-1			
WUA	25	75	100
Contracting	0	100	100
ID-2			
WUA	25	75	100
Contracting	76	24	100
Henan Province			
ID-1			
Contracting	0	100	100

Source: Authors' survey

However, the reduction in the water fees in most villages was quite modest. On average, water fees were reduced by only about nine per cent.

WATER MANAGEMENT AND CROP WATER USE

Although the major objective of water management reform is to save water, our study showed that water use in some areas that have established WUAs and contracting is lower than those areas still under collective management, and higher in others (table 3). For example, in the second ID in Ningxia (ID2), the water use per hectare in areas that have

TABLE 3
RELATIONSHIP BETWEEN SURFACE WATER MANAGEMENT AND CROP WATER USE IN THE SAMPLE IRRIGATION DISTRICTS (ID) IN CHINA, 2001

	Crop water use (M^3/ha)
Ningxia Province	
ID-1	
Collective	21,294
WUA	23,460
Contracting	30,969
ID-2	
Collective	16,549
WUA	15,483
Contracting	11,351
Henan Province	
ID-1	
Collective	13,052
Contracting	17,113
ID-2	
Collective	8,450

Source: Author's survey

WUAs and contracting arrangement is lower than those areas in which the collective still manages water (rows 5 and 6 versus row 4). However, in Ningxia's other ID (ID1) and in Henan, water use per hectare is higher in those villages that have shifted to WUAs or contracting (rows 1 to 3,7 and 8).

While the effectiveness of changing from collective to non-collective management in terms of water saving is not clear, the data show the importance of policy implementation. In particular, the importance of incentives in making the reforms work is shown when comparing water use in those villages that provide their managers with incentives with those that do not (table 4). After reform, when managers face incentives to earn profits

by saving water, use per hectare fell by nearly 10 per cent when compared to collectively managed systems across the sample in Ningxia (row 1, columns 1 and 3). In contrast, when leaders implemented water management reform without providing incentives, water use went up (column 2). When examining the individual IDs in Ningxia, it is seen that in both IDs water use fell more (or did not rise as much) when incentives were provided during reform than when they were not. In ID2, for example, water use fell in both non-

TABLE 4
RELATIONSHIP BETWEEN INCENTIVES AND CROP WATER USE IN THE SAMPLE IRRIGATION DISTRICTS

	Crop water use (m^3/ha)		
	Non-collective with incentives	**Non-collective without incentives**	**Collective**
Ningxia Province			
Whole samples	12729	20598	14003
ID-1	25055	26583	21924
ID-2	11188	14711	16549
Wheat	5619	7416	7489
Maize	7004	7704	7266
Rice	31307	31688	36949

Source: Author's survey

collective systems with and without incentives, but it fell further for those with (row 3). In ID1, although water use in the both non-collective systems rose, it did so by less for those with incentives (row 2). It is evident that the same patterns occurred in the case of individual crops (rows 4 to 6).

There was a positive correlation between incentives and water savings. In fact, many other factors correlated with incentives that create tendency of incentives and water savings to move together. In particular, it can be said that the cropping structure, the nature of the canal system's investment and the scarcity of water may affect the managerial type, the way that reforms are implemented and water use. As a result, multivariate analysis is required to analyse the relationship between water management reform, incentives, water use and other outcomes.

MULTIVARIATE EMPIRICAL MODEL AND RESULTS

Based on the above discussions, the link between water use per hectare and its other determinants are represented by the following equation:

$$W_{jk}=\alpha+\beta M_{k}+\gamma Z_{jk}+\varepsilon_{jk} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where w_{jk} represents average water use per hectare for household j in village k. The rest of the variables explain water use: M_k measures either the type of the water management institution or the nature of the incentives faced by the water manager; Z_{jk}, a matrix of control variables, represents other village and household factors that affect water use. Specifically, we include a number of variables to hold constant the nature of the village's production environment and its cropping structure. We include variables measuring the source of water (either surface or ground), the degree of water scarcity and the level of irrigation investment per hectare (a stock variable estimated as the sum of the investments made over the past 20 years).[4] Cropping structure is measured as the proportion of the village's sown area that is in rice. Household characteristics include age and education of the household head and the household's land endowment. Finally, our model also includes D_{jk}, a dummy variable representing the ID that serves the household. The symbols α, β and γ are parameters to be estimated and ε_{jk} is the error term that is assumed to be uncorrelated with the other explanatory variables in the initial equations, an assumption subsequently relaxed.

After holding other factors constant, the results showed that merely shifting management from the collective to either a WUA system or contracting arrangement by itself does not lead to water savings (table 5, column 1). The signs on the coefficients of the WUA and contracting variables are negative, suggesting that water use is lower in villages that have moved to non-collective management (rows 1 and 2). However, the standard errors are all large relative to the magnitude of the coefficients, meaning that nominal institutional reform has no significant impact on saving water.

When officials provide water managers with incentives, without regard to whether they have shifted to WUA or contract management, managers reduce water deliveries in the village (table 5, column 2). Econometric results show that the coefficient on the incentive indicator variable is negative and significant (although only at the 10 per cent level), when compared to the collective management, the omitted institutional type (row 3). In other words, without regard to the form of the water management institution, if managers face positive incentives, water use per hectare can be reduced by nearly 3,000 cubic metres, about 20 per cent of their typical water use.

Although interesting, it is possible that the estimated parameter is biased since water use per hectare and water management may be determined simultaneously with use or that the estimated coefficient is affect by unobserved heterogeneity. For example, it is possible that in areas that faced rising demand for water from cities, farmers naturally reduce water use in anticipation of future water restrictions. At the same time, village leaders in the areas may try to forestall the shortages by adopting new institutional arrangements to show that they are concerned about the possible water crisis. In such a situation, the coefficient on the water management institution (or incentive) variable could be negative, even if the institution itself has no effect.

TABLE 5
REGRESSION ANALYSIS OF THE DETERMINANTS OF CROP WATER USE AT THE HOUSEHOLD LEVEL

	Water use per hectare			
	OLS	**OLS**	**2SLS**	**2SLS**
Water management institutions				
Share of WUA	-1,311.0		-1,919.9	
	(0.70)		(1.00)	
Share of contracting	-703.7		-2,468.6	
	(0.49)		(1.34)	
Share of non-collective with incentives[a]		-2,843.7		-6,355.8
		(1.72)*		(1.99)**
Share of non-collective without incentives[a]		275.2		1,107.6
		(0.18)		(0.43)
Production environment				
Share of village irrigated area serviced by	2,390.7	2,141.8	2,560.5	2,494.7
surface water	(0.99)	(0.90)	(1.08)	(1.06)
Village water scarcity indicator variable	-3,574.1	-3,811.8	-3,463.5	-3,533.9
(1 = yes 0 = no)	(3.13)***	(3.34)***	(3.03)***	(3.13)***
Value per hectare of accumulated	-0.1	-0.1	-0.1	0.0
investment into village irrigation infrastructure	(1.01)	(0.52)	(1.11)	(0.23)
Cropping structure				
Share of sown area in rice in 1995	10,592.2	10,430.4	10,655.0	10,437.3
	(4.18)***	(4.17)***	(4.23)***	(4.18)***
Household characteristics				
Age of household head	(519.4)	447.4	551.8	517.2
	(1.17)	(1.02)	(1.25)	(1.18)
Age of household head, squared	-6.3	-5.6	-6.7	-6.3
	(1.28)	(1.15)	(1.37)	(1.29)
Education of household head	-81.9	-78.7	-79.2	-58.6
	(0.50)	(0.48)	(0.48)	(0.36)
Farm size	-10,486.7	-7,920.4	-8,964.5	-6,326.9
	(2.23)**	(1.64)	(1.89)*	(1.26)
Constant	14,261.4	15,130.4	13,821.5	12,514.5
	(1.43)	(1.53)	(1.39)	(1.27)
Observations	189	189	189	189
Adjusted R-square	0.44	0.45	0.45	0.45

Absolute value of t statistics in parentheses; coefficients of irrigation district indicator variables are omitted
[a] Non-collective institutions include WUA and contracting
** Significant at 10%; ** significant at 5%; *** significant at 1%*

In order to control for the potential endogeneity of water management types and incentives in the water use equation, an instrumental variable (IV) approach is adopted. To do so, prior to estimating equation (1), a set of variables can be regressed on the water management institution variable as follows:

$$M_k = \alpha + \beta IV_k + \gamma Z_k + \varepsilon_k \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where the predicted value of M_k from equation (2) would replace M_k in equation (1). Equation (2) includes Z_k, which are measures the other village-level control variables (same as in equation 1– e.g., measures of the village's production environment and cropping structure).

This IV procedure, however, is only valid if the variables in the IV matrix in equation (2) meet the definition of instruments. The key IV in the equation (2) that we use to address the endogeneity problem is a variable (P_k) that measures the effect of the decision of regional policymakers to push water management reform in village *k*. Such a measure should function well as an instrument, especially in our setting, since the officials responsible for promoting water management reform believed that at least in the short run they were choosing villages on a fairly random basis. An official in one ID told us that initially he went to villages in which he personally knew the local officials. If the spectrum of acquaintances of the typical water system officials are independent of the amount of water used in the village, the policy variable should meet the criteria of an instrumental variable: it is correlated with the decision of a village to participate in water management reform but does not have an effect on water use (or income or crop production) except through the influence of the reform. The age and education of the village leaders IVs are also included.[5]

Examining the results of equation (2) by itself, the model performs well (appendix C). The adjusted R-square statistics range from 0.23 to 0.94. Importantly, the results show that the water policy intervention variable, P_k, is positive and statistically significant; the variable meets the first criteria of an IV. Although the coefficient on the variables measuring village leader characteristics are insignificant, the Hausman test of the exclusion restrictions that are designed to test the validity of the instruments show that our instruments are statistically valid and meet the second criteria of IVs.[6]

When putting the predicted value of the water management variable into the water use model in equation (1), our results change little and largely support the findings from the OLS model (table 5, columns 3 and 4). Compared with OLS estimation, the t-ratio of the estimated coefficient also suggests that the savings from providing incentives are large. Holding other variables constant, in the villages in which leaders offer managers positive incentives, water use declines more than 6,000 cubic meter per hectare, which is about 40 per cent of average water use (row 3, column 4).

WATER MANAGEMENT, PRODUCTION, INCOME AND POVERTY

Management reform, at least when implemented as designed, leads to water saving and meets the primary goal of sector officials. However, it is possible that the success from such a policy can only come at a cost, either in terms of falling production or income or increased poverty. In this section, we examine how water management reform affects agricultural production. We then examine its impact on income and the incidence of poverty.

The study showed that water management reform negatively influences agricultural production (table 6, rows 1 to 3). Compared with collective management, in the villages that provide incentives to managers to save water, wheat yields decline by nearly 10 per cent. Maize and rice yields also decline by 9 and 12 per cent. The negative effect of incentives on production is clearer when the yields between villages that nominally implement reforms but do not provide incentives to water managers with those that do provide incentives (rows 1 to 3, column 1 versus 2) are compared. In the case of wheat and maize yields, while production in villages with managers that have positive incentives fall, those in villages that have moved to WUAs and contracting arrangement, but have not provided incentives, actually rise marginally. In the case of rice, yields fall for villages that implement reform nominally fall, but not as far as villages that provide incentives to their managers. Since the pattern of production is consistent with, though in the opposite

TABLE 6
INCENTIVES, PRODUCTION, INCOME AND POVETY IN THE SAMPLE IRRIGATION DISTRICTS (IDS), NINGXIA AND HENAN PROVINCES, 2001

	Non-collective with incentives[a]	Non-collective without incentives[a]	Collective
Wheat yield (kg/ha)	4340	4827	4800
Maize yield (kg/ha)	5328	6031	5801
Rice yield (kg/ha)	6288	6499	7155
Income (yuan)	2334	1966	1646
Cropping income (yuan)	1073	784	726
Poverty incidence (%)	11.1	6.5	7.5

[a] Non-collective institutions include WUA and contracting
Source: Author's survey

direction of, the correlations between water management and water use, the study suggest that water savings through management reform may only be able to come at a cost of lower yields.

In contrast, the negative influence of water management reform on production does not appear in the descriptive statistics when examining farmer income (table 6). Evidence from our survey in the villages in which leaders reformed their water management system and provided incentives to managers, reveals that farmers actually earn higher income (rows

4). Surprisingly, crop income is higher in villages that have provided managers with incentives (row 5). Part of the explanation for the difference between yields and income may be due to the fact that water fees fall in villages that have implemented reforms. It may be also that farmers shift their production decisions and allocate labour to other enterprises in villages that provide water managers with incentives. Econometric analysis is needed to isolate the effect of reform on income. Such analysis is also needed to distinguish between income and poverty effects; in contrast to the case of income, the study show that poverty is worse in those villages that provide managers with incentives (row 6).

MULTIVARIATE EMPIRICAL MODEL AND RESULTS

In addition to water management reform, other socio-economic factors influence agricultural production, income and poverty. In order to answer whether water management reform affects outcomes, it is necessary to provided control for these other factors. To do so, it is necessary to specify the link between agricultural production and its determinants as

$$Q_{ijk}=\alpha+\beta W_{ijk}+\gamma X_{ijk}+\delta Z_{ijk}+D_{ijk}+\varepsilon_{ijk}\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

where Q_{ijk} represents the yields of wheat, maize or rice from the i^{th} plot of household j in village k. In equation (3), yields are explained by the variable of interest, W_{ijk} which measures water use per hectare, X_{ijk}, which measures other inputs to the production process, Z_{ijk} which holds other factors constant, including characteristics of the production environment of the village, household and plot, and the irrigation district dummy, D_k. Agricultural production inputs include measures of per hectare use of labour (measured in man days), fertiliser (measured in aggregated physical units[7]) and expenditures on other inputs, such as fees paid for custom services. The control variables for village and household characteristics are the same as for equation (1) except when the village level cropping structure is not used. The five plot characteristics, including measures of: two soil type variables; plot location (distance from the plot to the farmer's house); whether the crop on the plot is planted in rotation with another crop or not (single crop equals one, zero otherwise); and production shocks (measured as yield reduction on a plot due to floods, droughts or other 'disasters'), is also added.

The impact of reform is measured through the water use variable. If production responds positively to water use, then it can be deduced that reform will have an effect in the opposite direction, because of its water reducing effect seen in table 5. However, because Table 5 combined all crops together at the household level and in the production analysis we examine wheat, maize and rice separately at the plot level, we need to have separate measures of the effect of water management reform on water use by crop. The results of

these alternative water use equations (are included in annex D) show that in the case of all crops, the coefficient on the variable measuring the presence of incentives in local water management institutions is negative (and is significantly so for wheat and rice).[8] Predictions from Appendix D are used in the estimation of equation (3).

The following equation examines the relationship between income and other factors:

$$Y_{jk}=\alpha+\beta M_{jk}+\gamma Z_{jk}+D_{jk}+\varepsilon_{jk} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

where y_{jk} represents either total or cropping income per capita for household j, and the other variables, including Mjk, our interested variable (a measure of incentives) are the same as in equation (1). In examining the effect of water management reform on poverty, we proceed in largely the same way. Because we are measuring poverty in terms of income, one would use largely the same specification and expect similar results, albeit with opposite signs.

Almost all the models analysing the effect of water reform on production, income and poverty perform well and produce robust results that largely confirm our a priori expectations (table 7 to 9). The goodness of fit measure for production and income models ranges from 0.16 to 0.40. Many coefficients of the control variables were of expected sign and statistically significant. For example, the production shock variables showed that droughts and floods not only negatively influences agricultural production, but also reduces farmer income and adversely affects the household's poverty status. Households with larger farm size also positively affect incomes.[9]

The study showed that water management reforms reduced wheat yield while it had no significant impact on the yields of maize and rice. From the wheat water use model, when villages provide water managers with incentives, managers reduce water use per hectare about 3,800 cubic meters, a decline of about 50 per cent (annex D, column 1, row 1). At the same time, the coefficient on the predicted water use variable in the wheat yield is positive and statistically significant (table 7, column 1, row 1). The estimated use elasticity for wheat yield is 0.226. Overall, our estimates of the size of the decline in water use and the responsiveness of wheat yields to water use imply that management reform reduces wheat yields by about 11 per cent. In contrast, although we find that incentives have a negative association on water use, the estimated water use elasticities for maize and rice are indistinguishable from zero (table 7, columns 2 and 3, row 1).

If the plot level analysis of water management and production are correct, then this would mean that in the sample areas the main trade-off between the water savings from management reform and production occurs for wheat and is less severe or absent for maize and rice. The conclusion is plausible and, although its validity may only be true for our sample region, it is consistent with many of the field observations. Wheat depends

TABLE 7
REGRESSION ANALYSIS OF THE DETERMINANTS OF CROP YIELD (2SLS)

	Log of crop yield per hectare		
	Wheat	**Maize**	**Rice**
Production inputs			
Log of water use per hectare[a]	0.226	0.043	0.148
	(3.15)***	(0.32)	(1.05)
Log of labour use per hectare	-0.009	0.099	-0.003
	(0.26)	(1.51)	(0.07)
Log of fertiliser use per hectare	0.020	0.110	0.182
	(0.44)	(1.75)*	(2.53)**
Log of value of other inputs per hectare	-0.001	-0.002	0.018
	(0.09)	(0.21)	(1.49)
Production environment			
Share of village irrigated area serviced by	0.197	-0.027	0.103
surface water	(2.39)**	(0.13)	(0.62)
Village water scarcity indicator variable	0.086	0.029	0.133
(1 = yes 0 = no)	(1.63)	(0.23)	(1.38)
Value per hectare of accumulated	0.000	0.000	0.000
investment into village irrigation infrastructure	(0.51)	(1.18)	(2.21)**
Household characteristics			
Age of household head	-0.028	-0.020	-0.029
	(1.74)*	(0.76)	(1.04)
Age of household head, squared	0.000	0.000	0.000
	(2.13)**	(0.85)	(0.77)
Education of household head	0.023	0.006	-0.016
	(3.04)***	(0.55)	(1.45)
Plot characteristics			
Loam soil	0.081	0.137	0.077
(1 = yes 0 = no)	(1.75)*	(1.80)*	(1.16)
Clay soil	0.095	0.154	0.039
(1 = yes 0 = no)	(2.04)**	(2.08)**	(0.60)
Distance to home	-0.008	0.016	-0.016
	(0.24)	(0.25)	(0.49)
Single crop	0.061	-0.010	-0.029
(1 = yes 0 = double cropping)	(0.82)	(0.09)	(0.13)
Production shocks			
Yield reduction due to production shocks	-1.411	-1.026	-1.469
	(10.37)***	(4.94)***	(7.45)***
Constant	6.365	7.310	6.698
	(7.96)***	(4.73)***	(4.27)***
Observations	234	158	113
Adjusted R-square	0.40	0.16	0.37

[a] predicted water use by the determinants of water use model (Appendix D)
Absolute value of statistics in parentheses; coefficients of irrigation districts are omitted
˙ Significant at 10%; ¨ significant at 5%; ¨˙ significant at 1%

TABLE 8
REGRESSION ANALYSIS OF THE DETERMINANTS OF FARMER INCOME

	Total income per capita		Cropping income per capi	
	OLS	**2SLS**	**OLS**	**2SLS**
Water management institutions				
Share of non-collective incentives [a]	175.1	689.0	-136.3	69.7
	(0.53)	(1.08)	(1.06)	(0.28)
Share of non-collective without incentives [a]	-18.3	-108.3	-61.4	-95.2
	(0.06)	(0.21)	(0.54)	(0.47)
Production environment				
Share of village irrigated area serviced	337.7	301.0	-112.9	-126.0
by surface water	(0.73)	(0.66)	(0.62)	(0.70)
Village water scarcity indicator variable	157.5	145.0	-15.8	-3.2
(1=yes 0=no)	(0.70)	(0.66)	(0.18)	(0.04)
Value per hectare of accumulated	0.069	0.056	0.012	0.007
investment into village irrigation infrastructure	(3.37) ***	(2.08)**	(1.54)	(0.65)
Cropping structure				
Share of village rice area in 1995	198.9	198.0	-57.0	-59.4
	(0.41)	(0.41)	(0.30)	(0.32)
Household characteristics				
Age of household head	183.5	178.6	49.6	51.9
	(2.13)**	(2.07)**	(1.48)	(1.53)
Age of household head, squared	-1.759	-1.710	-0.587	-0.609
	(1.84)*	(1.79)*	(1.57)	(1.62)
Education of household head	22.0	19.9	-7.9	-8.1
	(0.70)	(0.63)	(0.65)	(0.66)
Farm size	3,291.1	3,034.1	3,270.8	3,167.3
	(2.99)***	(2.71)***	(7.48)***	7.07)***
Total productive asset per capita	0.111	0.110		
	(3.49)***	(3.45)***		
Assets used in agricultural production per capita			0.081	0.080
			(1.76)*	(1.74)*
Number of plots per household	-124.1	-127.8	-3.1	-7.4
	(3.68)***	(3.79)***	(0.24)	(0.56)
Production shocks				
Production shocks	-229.3	-219.7	-183.2	-180.5
	(1.23)	(1.18)	(2.52)**	(2.47)**
Constant	-2,707.9	-2,458.5	-472.6	-460.0
	(1.41)	(1.29)	(0.63)	(0.61)
Observations	189	189	189	189
Adjusted R-square	0.24	0.25	0.35	0.35

Absolute value of statistics in parentheses; coefficients of irrigation district are omitted
[a] Non-collective institutions include WUA and contracting
[b] Productive assets include assets used for agricultural and ono-agricultural production activities.
*. significant at 10%; ** significant at 5%;*** significant at 1%*

TABLE 9
REGRESSION ANALYSIS OF THE DETERMINANTS OF POVERTY

	Dummy of poverty	
	OLS	**2SLS**
Water management institutions		
Share of non-collective with incentives[a]	0.086	0.057
	(1.21)	(0.41)
Share of non-collective without incentives[a]	0.032	-0.040
	(0.52)	(0.36)
Production environment		
Share of village irrigated area serviced by	-0.175	-0.167
surface water	(1.75)*	(1.68)*
Village water scarcity indicator variable	0.001	-0.008
(1 = yes 0 = no)	(0.03)	(0.16)
Value per hectare of accumulated investment into	-0.000	-0.000
village irrigation infrastructure	(1.07)	(0.85)
Cropping structure		
Share of village rice area in 1995	0.012	0.018
	(0.12)	(0.17)
Household characteristics		
Age of household head	0.007	0.009
	(0.40)	(0.45)
Age of household head, squared	-0.000	-0.000
	(0.53)	(0.60)
Education of household head	-0.009	-0.010
	(1.39)	(1.40)
Farmer size	-0.297	-0.261
	(1.24)	(1.07)
Total productive asset per capita	-0.000	-0.000
	(0.76)	(0.72)
Number of plots per household	0.124	0.127
	(1.70)*	(1.79)*
Production shocks		
Dummy of production shocks	0.095	0.095
(1 yes 0 no)	(2,36)**	(2.33)**
Constant	0.083	0.087
	(0.20)	(0.21)
Observations	189	189
Adjusted R-square	0.01	0.01

Absolute value of statistics in parentheses; coefficients of irrigation districts are omitted
[a] Non-collective institutions include WUA and contracting
** significant at 10%; ** significant at 5%; *** significant at 1%*

more than any other on irrigation because its growth period occurs almost entirely during the dry season. Thus, cutbacks in water supply should be expected to reduce yields. Maize, in contrast, is grown during the wet season and managers who have an incentive to save water may be able to coincide irrigation with the rains while those that have no interest in saving water might adhere to a predetermined water delivery schedule, no matter what the weather may be like. In the case of rice, although the crop is dependent on large volumes of water, experiments by domestic and international water scientists have shown that there are many new ways of managing rice irrigation (e.g., alternative wetting and during) (Barker *et al.,* 2002) that can lead to water savings but do not have significant yield effects. New water management technologies, however, require investment of effort to learn and implement. The study, then, may demonstrate that it is managers with incentives that have been able and willing to use these new technologies that have brought water savings without large yield declines.

Our study results also demonstrate that water management reform has no statistically significant impact on farmer incomes (tables 8 and 9). When either an OLS or 2SLS approach is used, the coefficients on the incentive variables in the both total and cropping income models are not statistically significant. Consistent with the descriptive statistics (which find no obvious fall in income in those villages that give water managers incentives), our results may suggest that whatever negative income effect there is from falling wheat production, it is being offset partially by reductions in water fees (though, as seen above, the reductions in water prices were fairly small). It could also be that the average wheat yield, 4,740 kg per hectare, times average area of wheat sown per household, 0.17 hectare, times the price of wheat, 1 yuan per kg) that they cannot be detected statistically. Moreover, since the fall in household income is less than 1.2 per cent, the losses in cropping likely are being offset by other actions taken by households (e.g., because water management is better, it is possible that farmers can focus more on other economic activities).

Similar results also can be found in the poverty model. Since poverty status is measured as 'under the poverty line or not,' the results suggest that there is no effect of a village's decision to provide managers with incentives on household poverty status. If universally true, such a finding would be important, since critics of water management reform often point out that one possible adverse consequence of using incentives to induce water savings is that managers may cut back on deliveries to marginal users, who may be those on the poorest land with the lowest income. The results here, however, should be interpreted with caution. First, the study does not identify what may be behind this result. In many villages, leaders have specified strict rules in their agreements with water managers that they cannot exclude households from water allocation schedules. Second, as seen by examining the estimated equations in Table 9, only a few of the coefficients are significant, suggesting that the sample size may be too small to identify poverty effects. In short, while interesting, it is clear that the results may be more important as a tool that raises awareness

of possible associations rather than providing definitive answers. Future research should try to pinpoint the source of this effect and use larger data sets to strengthen understanding of these issues.

CONCLUSION

This paper has sought to understand some elements of the reform of China's surface water management systems and its effect on water use, output, income and poverty. Research results show that since 1990, WUAs and contracting arrangement have replaced collective water management. In some regions, the reform institutions have become the dominant form of management. Spread by the efforts of water officials, the study shows that implementation has often deviated from theory. Participation by farmers has played only a minor role in most villages. In some villages, reform has been only nominally implemented, and there are few difference when comparing the 'reform' institutions to traditional management forms. In part because of these implementation problems, the analysis shows that nominal reform has had little effect on water use.

The absence of a systematic relationship between nominal reform and water use, however, does not mean that the entire reform process has failed. Indeed, one of the main features of China's water management reforms, the provision of incentives to water managers, appears to have succeeded in achieving large water savings while having only a small or no effect on agricultural production or rural incomes. The findings demonstrate that in villages that provided water managers with strong incentives water use fell sharply. The incentives must have improved the efficiency of the irrigation systems since the output of major crops, such as rice and maize, did not fall, and rural incomes and poverty remained unchanged. Only wheat production fell. Although the study needs to be undertaken in other areas before the results can be generalised to the rest of China, at least in the sample sites that provided manager incentives, water management reform has been nearly a win-win policy. It is seen that little if any effect of participation by farmers on water use in our sample sites can be found.

Overall, the findings conclude that the government should continue to support water management reform. Officials that prefer reforms to succeed should make an effort to ensure that more emphasis be given on the effective implementation. Although the negative impacts on production and farmer income were not seen, in the longer run, as water management reform reaches into more water scarce areas and seeks to continue to achieve savings in areas that have already cut back on use, there may be sharper trade-offs between water use and production and income. When the trade-off are larger, officials still may choose to opt for pushing reforms that save water. In these cases, since the farmers that lose access to water could also suffer production and income falls, policies to mitigate the adverse consequences should be developed.

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NOTES

[1] The two IDs in Ningxia Province are Weining Irrigation District and Qingtongxia Irrigation District. The IDs in Henan Province are People's Victory Irrigation District and Liuyuankou Irrigation District.

[2] During China's economic reforms, many government services have been contracted out to private individuals, including grain procurement, extension and health services.

[3] Once the manager collects that total fee from the farmer, he turns the basic fee part to the village accountant who in turn sends it to the township which is supposed to use the funds to maintain the township's canal infrastructure.

[4] The degree of water scarcity is an indicator variable developed from a question included in the village questionnaire. Enumerators asked village leaders to characterise the nature of water resources in their village. The leaders chose one of three pre-coded answers: 1=water is very scarce; 2=water is relatively scarce and frequently constrains agricultural production; and 3=water is not short (at least currently). The indicator variable takes on the value of one if the leader responded either 1 or 2; and zero if when he responded 3.

[5] We include village leader characteristics as IVs, following Brandt *et al* (2003) and Li (1998). In these papers, the authors claim that village leader characteristics may affect reform in the village, but their characteristics would not have an independent effect on production decisions (in our case, water use).

[6] To test if the set of identifying instruments are exogenous, a Lagrange multiplier test can be used (Hausman). The chi-square-distributed test statistic with four degree if freedom, is $N*R^2$, where N is number of observations, and R^2 is the measure of goodness-of-fit of the regression of the residues from the water use equation (1) on the variables which are exogenous to the system. The test statistics are 0.76 for WUAs, 2.92 for contracting, 1.68 for non-collective with incentives and 5.51 for non-collective without incentives. The test results indicate the null hypothesis that there is no correlation between the exogenous instruments and the disturbance term from water use equation (1) cannot be rejected.

[7] To measure fertiliser, we decomposed each type of fertiliser by nutrients, N, P and K, and then summed across nutrients and fertiliser types. We also aggregated fertiliser by value and our main results of interest do not change.

[8] The analysis uses plot level data for estimating the equation in Appendix D. We also use predicted values of water management reform for the estimation of the equations in Appendix D because of our concerns of endogeneity.

[9] Although the coefficients on the fertiliser variable in the maize and rice yield equations are positive, significant and similar to results found elsewhere in the literature (e.g., Putterman and Ciacu, 1995), as found in much of the literature on cross section production analysis at the household level, our other coefficients are insignificant due to measurement problems (e.g., we observe labour days, not efforts), multi-collinearity (e.g., when farmers use high levels of one input, they often use high levels of all other inputs), and endogeneity (management ability and weather shocks are not measured completely).

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ANNEX A

Calculation of crop water use

Because measuring water use in villages that use surface water is always a difficult task, during the enumeration process we developed a methodology in each community and asking about water use in a number of ways. To implement this strategy, we included special blocks on water use in both the village and canal manager forms. We also asked ID officials in each area for information that could be used to check our survey-based estimates. We not only asked the respondents to provide estimates of water use per hectare on a cubic meter basis, but also recorded other information about the application process, such as the length of time that it took to apply water in the village, the depth to which the average field was flooded, the type of the soil, and the area irrigated. We elicited these data for each irrigation for each crop during the season.

The data that we collected in the different survey forms were used to create a household-level (and plot-level) measure of average water use per hectare for each crop for each village. The first step involved comparing the direct estimates of water use per hectare from village leaders and canal managers by crop and by irrigation. If both of these respondents provided estimates, and neither estimates exceeded or fell below the feasibility range that was estimated by the local ID officials, we averaged the two estimates. According to our survey, nearly 80 per cent of village leaders and canal managers were able to provide relatively accurate estimates of this number. If one or both of the respondents were unable to provide a direct estimate of water use, we then used the other information about the village's irrigation system (e.g., length of time that it took to apply water in the village, the depth to which the average field was flooded, the type of the soil and area irrigated) to predict water use. We used these predictions in the same way as the raw data and compared them to the estimates of the other respondent and boundaries set by the local ID officials. At this point of the analysis, each village had a set of parameters that measured the average amount of water used per hectare per irrigation for each crop. Combining these parameters with ploy level data (which provided information on the number of irrigations used on each crop by each household), we were able to aggregate across crops (weighted by their area shares) and produce a household-level measures of water use per hectare.

ANNEX B

Descriptive statistics for major variable

	Mean	Standard deviation	Minimum	Maximum
Share WUA management	0.14	0.34	0	1
Share of Contracting	0.22	0.39	0	1
Share of non-collective with incentives	0.16	0.36	0	1
Share of non-collective without incentives	0.20	0.39	0	1
Dummy of governmental intervention for WUA	0.14	0.35	0	1
Dummy of governmental intervention for Contracting	0.30	0.46	0	1
Age of village leader (year)	43	7	29	55
Education of village leader (year)	9	3	0	15
Share of village water scarcity indicator variables	0.73	0.41	0	1
Village water scarcity indicator variables	0.27	0.45	0	1
Value per capita of accumulated investment into village irrigation infrastructure (yuan)	2824	4881	0	33943
Share of village rice area in 1995 (%)	0.19	0.21	0	0.80
Household crop water use per hectare (m^3)	15365	8739	627	44580
Wheat water use per hectare (m^3)	5937	3909	300	21000
Maize water use per hectare (m^3)	6936	4802	360	27750
Rice water use per hectare (m^3)	28882	18572	1381	89072
Household total income (yuan)	1855	1426	-42	11087
Household cropping income (yuan)	806	604	-135	4285
Dummy of poverty	0.08	0.27	0	1
Age of household head (year)	44	9	24	66
Education of household head (year)	6	3	0	15
Farm size (ha)	0.17	0.12	0.03	1.03
Total productive asset per capita (yuan)	1434	2972	2	32533
Assets used in agricultural production per capita (yuan)	906	857	1	4800
Number of plots per household (number)	7	4	1	23
Dummy of production shocks	0.52	0.50	2	1
Wheat yield per hectare (kg)	4740	1253	375	8625
Maize yield per hectare (kg)	5760	1770	600	10125
Rice yield per hecatre (kg)	6900	1740	1125	12855

Source: Authors' survey

ANNEX C

Regression analysis of determinants of water management institutions at the village level

	(1)	(2)	(3)	(4)
	Share of WUA	**Share of contracting**	**Share of non-collective with indentives tomanagers[a]**	**Share of non-collective without incentives to managers[a]**
Water policy				
Dummy of governmental intervention	0.864	0.670	0.212	0.424
	(22.43)***	(7.72)***	(2.10)**	(4.53)***
Characteristics of village leaders				
Age of village leader	0.000	-0.017	-0.013	-0.003
	(0.21)	(3.32)***	(1.80)*	(0.47)
Education of village leader	0.002	-0.005	-0.029	0.021
	(0.45)	(0.37)	(1.43)	(1.13)
Production environment				
Share of village irrigation area	0.004	0.182	-0.078	0.263
serviced by surface water	(0.08)	(1.23)	(0.38)	(1.39)
Village water scarcity indicator variable	-0.001	0.086	0.015	0.060
	(0.06)	(1.16)	(0.15)	(0.63)
Value per hectare of accumulated	0.000	0.000	0.000	0.000
investment into village irrigation	(10.43)***	(0.54)	(2.40)**	(0.28)
infrastructure				
Cropping structure				
Share of village rice area in 1995	0.016	-0.051	-0.055	0.043
	(0.27)	(0.32)	(0.25)	(0.21)
Constant	-0.067	0.716	0.770	-0.001
	(0.53)	(2.00)*	(1.53)	(0.00)
Observations	51	51	51	51
Adjusted R-square	0.94	0.65	0.23	0.42

Absolute value of statistics in parentheses; coefficients of irrigation districts are omitted
[a] Non-collective institutions include WUA and contracting
** significant at 10%;** significant at 5%;*** significant at 1%*

ANNEX D

Regression analysis of determinants of crop water use at the plot level

	Water use per hectare		
	Wheat	**Maize**	**Rice**
Water management institutions			
Share of non-collective with incentives[a]	-3,802.4	-2,107.7	-23,149.1
	(2.83)***	(1.09)	(2.24)**
Share of non-collective without incentives[a]	-1,054.2	992.5	-5,943.3
	(0.96)	(0.63)	(0.64)
Production environment			
Share of village irrigated area serviced by	61.9	-1,555.1	1,018.3
surface water	(0.06)	(0.64)	(0.10)
Village water scarcity indicator variable	-1,911.9	-3,510.1	-11,202.8
(1 = yes 0 =no)	(3.90)***	(4.45)***	(2.75)***
Value per hectare of accumulated investment	0.110	0.090	-1.948
into village irrigation infrastructure	(1.79)*	(1.02)	(1.83)*
Cropping structure			
Share of village rice area in 1995	-3,210.4	-1,106.9	11,146.2
	(2.79)***	(0.54)	(0.96)
Household characteristics			
Age of household head	29.1	-251.4	2,779.0
	(0.16)	(0.84)	(1.68)*
Squared age of household head	-0.560	2.725	-32.915
	(0.28)	(0.82)	(1.80)*
Education of household head	-198.5	-144.9	-687.5
	(2.91)***	(1.31)	(1.18)
Arable land per household	-218.5	-5,470.1	25,745.9
	(0.10)	(1.76)*	(1.61)
Plot characteristics			
Loam soil	348.0	-309.5	1,619.0
(1 = yes 0 = no)	(0.66)	(0.36)	(0.38)
Clay soil	358.5	-44.9	1,204.3
(1 = yes 0 = no)	(0.68)	(0.05)	(0.29)
Distance to home	-51.9	1,119.1	190.5
	(0.15)	(1.57)	(0.10)
Single crop	841.5	1,429.9	-2,000.7
(1 – yes 0 = double cropping)	(1.04)	(1.25)	(0.15)
Constant	12,469.8	18,713.8	-3,738.9
	(3.00)***	(2.64)***	(0.10)
Observations	234	163	114
Adjusted R-square	0.41	0.31	0.30

Absolute value of statistics in parentheses; coefficients of irrigation districts are omitted
[a] Non-collective institutions include WUA and contracting
** significant at 10%;** significant at 5%; *** significant at 1%*

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BOOKREVIEW

WATER: PERSPECTIVES, ISSUES, CONCERNS

BY RAMASWAMY. R IYER

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REVIEWED BY **AJAYA DIXIT**

The end of the Second World War and the emergence of India and Pakistan as two independent nations in the Sub-continent coincided with a reaffirmation of faith in Western technology as the engine of well-being and happiness. The notion that prosperity, well-being and happiness could be enjoyed by the country's citizens had remained a dream relegated to the aftermath of life until it was brought to earth during the utilitarian achievement of the eighteen-century European Enlightenment. Happiness ensued when three factors converged: a person's rational self-interest, his/her material betterment, and progress in the conditions of and opportunities in society.[1] The Western world's material accumulation and its superiority in the global arena in the nineteenth century had demonstrated that technology was a very effective instrument, as a mechanism for achieving societal well-being. At a more tangible level, citizen of Western countries began to have greater access to safe water, health services and affordable energy than non-Western countries did.

The notion of societal happiness that came to South Asia during the colonial era also carried with it an ideological baggage. The British introduced to South Asia the rule of law rather than of the individual, market economics, the secularisation of governance, liberty and equality of opportunity. These ideas were, if not alien, at least not being practiced by the autocratic, religion-dominated structure of inequality in South Asia. The clash of the two different worldviews ended with the British prevailing and imposing their colonial project on a then undivided India. The transplant, however, was not perfect. The poor quality of water-related civic services, for example, reflects systemic flaws in governance as a manifestation of the imperfect transplant.

The above context has important implication for charting out a future course of action designed to address water-related constraints because we need a deeper understanding of the underlying issues than exist at present. Making the shift for better

understanding to new policies is a difficult task and perhaps one requiring several interdisciplinary studies. In the endeavour, scholars will have to dig into and review many documents: from academic treatises to activist writings, as well as the views of the establishment and of the market. They will have to glean lessons from different geographies at various scales and weave them into the larger social, economic political and ecological whole. Ramaswamy Iyer's book *Water, Perspectives, Issues and Concerns* should find an important place as a source.

The book provides a flexible lens through which India's water policy terrain is seen not only by an 'insider' enjoying the perspective as the secretary to the Government of India (GoI) but also subsequently as an independent 'outsider'. While reviewing the book Professor A. Vaidyanathan of the Madras Institute of Development Studies (MIDS) has suggested that "Ramaswamy Iyer is eminently qualified for this task as he has a wealth of first hand knowledge and experience of government policymaking and implementation as secretary to the ministry of water resources." After retirement, however, Iyer started looking at water as an outsider, prompting Vaidayanathan (2004) to suggest that, "Iyer became increasingly disenchanted with the current strategy and priorities in relation to water and emerged as one of its most articulate and informed critics." In another review, Kanchan Chopra (2004) suggests that Iyer's book is a "veritable storehouse of knowledge for scholars interested in the political economy of water resource management in South Asia".

Iyer began his journey as an independent analyst of water policies in South Asia in the late 1980s, after he retired as secretary to the GoI. I first met Iyer in the early 1990s while I was working on a component of a Ford Foundation-funded research project on the cooperative development and management of the Ganga, Brahmaputra and Meghna rivers. At first, I found Iyer distant and perhaps even bureaucratic. But as we continued to interact, the distance vanished and behind the formal persona I discovered a warm and sensitive individual committed to establishing water as what it really is: a wholesome part of human civilisation, livelihood, economy, society and nature. We met on many occasions—in New Delhi, Calcutta, Tehri, Haradwar, Colombo, Chennai, Islamabad and Kathmandu—to discuss, debate and learn how complex developing and managing water in South Asia was. His commitment to water was most evident in the 2000 Water Forum in The Hague. He shared a bunk bed in a family holiday hut on the Dutch coast with three Nepali, one Bhutani and one Indian participant. He enjoyed the 'experimental cuisine' that we prepared together with neither hierarchy nor national division. The humility the former secretary of GoI, demonstrated by sleeping in the same hut with social and environmental activists of all shades reinforced our respect for Iyer.

For me, these engagements have paid rich dividends in understanding of the myraid issues of water and its management. Our only point of disagreement lies in our respective interpretations of the 1996 Treaty on the Mahakali River between the governments of

Nepal and India. This treaty sets the stage for building the 315-m-high Pancheswar High Dam on the Mahakali River. Perhaps based on his pragmatic view of bilateral relationship between two neighbours, Iyer, despite his lack of enthusiasm for large dams, suggests, "we can take a view that any accord, however, imperfect, is better than discord; the failure of the Treaty will be fraught with serious consequences for the relation between two countries, and every thing possible must be done to make Treaty work to the advantage of both countries regardless of any reservation that one may have on some of the content". This quote is part of his response to a joint article entitled, "How not to do a South Asian treaty" I wrote with Dipak Gyawali and which was published in *Himal South Asia*. I, however, disagreed with Iyer's views. When I met him a few months after his view was published, I posed him a question: "If a high dam conceived in the existing socio-economic context is not pro-people for India, how can it be so for Nepal simply because the two governments have signed an agreement to build it?" He seemed to understand my feelings but continued to emphasise the need for good relations between two neighbours.

There are many other ways of building a more stable cooperative relation between Nepal and India in water resource development. The problem with the Mahakali Treaty is that such alternatives were never ever contemplated despite suggestions from civil society members about creative thinking outside the box. This reviewer had one such opportunity, when along with Dipak Gyawali (2001) and Rishi Shah of Royal Nepal Academy of Science and Technology, we suggested to the then-Indian Ambassador K. V. Rajan that such efforts need to begin with projects that do not involve water sharing (such as with run-of-river hydropower projects). The initiative, we argued, would need to be formulated in a way that would help strengthen the technical capacity of Nepali professionals and industries and, in the process, build cooperative institutions. Dipak Gyawali has already recounted this event in his book *Water in Nepal*. But such more 'doable' paths were never seriously explored. The two neighbours, which last cooperated in 1984 when they constructed the 14.5-MW Devighat Hydropower Project made a Hanuman-sized leap to build the 6,480-MW Pancheswar Project. A simple arithmetical trend analysis would have shown how impossible it is to make a 500 times quantum jump without intermediary stages of institution building.

Members of civil society raised many questions about the Mahakali Treaty. Before it was ratified there were street protests, during which politicians expressing opposing views, including former prime minister Kirti Nidhi Bista, were arrested. Disagreement over the elements of the Treaty led to the splitting of United Marxist Leninist Party. It was during the process of ratification that Nepali Parliament was sucked into a cesspool of corruption. On 13 February, 1996, the Communist Party of Nepal (Maoist) declared its People's War. This was the day after prime ministers Sher Bahadur Deuba and the late Narasimha Rao re-signed the Mahakali Treaty in New Delhi. One of the demands by the Maoist was the scrapping of the Mahakali Treaty, though subsequently this party has made little public

statement on this issue. The choice of this path had serious ramifications for Nepal's national politics and security, and was to burst open in a violent form.

It is too farfetched to attribute Nepal's insurgency or the split of major political parties to the signing of a treaty which aimed to foster cooperation between neighbours. But what followed is more than a simple coincidence. The signing of the Mahakali Treaty is among the many factors that has de-legitimised the country's political middle ground and precipitated the present crisis. That, however, is a subject for more detailed analysis by those in academia, civil society and the establishment.

Iyer believes in a creative engagement between the establishment and those advocating alternatives (read 'activists') and his faith seemed to rest on the outcome of the World Commission on Dams (WCD). In an earlier issue of *Water Nepal*, he wrote

> "Every one is expected to declare his or her position for or against dams: any one who refuses to do so, but address hard questions to both sides, is likely to please neither! I wonder whether we shall get a definitive pronouncement on this vexed controversy after two years, when the World Commission on Dam recently set up by the World Bank and the World Conservation Union submits report."[2]

That, unfortunately, did not happen, and Iyer laments, "the degree of enlightenment that was beginning to emerge ten years ago in South has seen a degree of reversal" (p. 16). Subsequent to the publishing of the WCD report, the position of both government hydrocracies and social activists has hardened, further polarising the debate in the contested water policy terrain. Iyer admits, "Having taken two steps forward during the last decade or two, the MoWR has now taken at least two steps backward. There is a strident reassertion of the dominance of the engineering point of view, and a deprecation of the other perspectives." In Nepal, however an effort was made to engage in policy dialogue that compared WCD's guidelines with the country's laws, acts, policies, and regulations (Dixit *et al.*, 2004). Dam managers and builders and civil society activists were involved in the process, and the stage for continuing the process has been set. One analyst commented that this was a unique process, which involved NGOs, activists, and academic in a response to the Commission's findings.[3]

In the same *Water Nepal* article, Iyer suggested that those who espouse alternative approaches must be better organised and that 'strenuous efforts need to be made to recover lost ground' related to the two backward steps made by the Ministry of Water Resources (MoWR) in India. Though he does not explicitly state it, Iyer's book underscores the view that the development thought and practice of the last hundred fifty years has followed the dominant paradigm of the industrialised North. The paradigm emphasises

individualism, technological efficiency and material growth and neglects aesthetic, ethics and community fabric. These elements are central to development and cannot be treated as incidental externalities to a development model, conceived of as linear, measurable, predictable and subject to universal treatment with economic tools alone.[4] Water development in the United States, in particular, using such an approach has shown that prosperity came with huge social and environmental costs, and experiences in many developing countries are similar.

Iyer showed an appreciation of the costs in an article in the *Economic and Political Weekly* in 1989. As the Secretary during Rajiv Gandhi's tenure as India's Prime Minister, Iyer called for extreme caution in approving large-dam projects and only after 'considering the heavy (financial, human, social and environmental) costs'. Khagram (2004) suggests that "this was a dramatic shift for Iyer, who in 1987, played a central role in convincing Prime Minister Rajiv Gandhi to grant an environmental clearance so that construction could begin on the controversial Sardar Sarovar Project a major dam component of the larger Narmada Projects."

Iyer candidly describes what brought about such changes in chapter 16 of his book: "increasing awareness of the kind of impact that such projects had and the difficulties of countering them; better understanding of the limitations of EIAs, exposure to difficult and critical questions in seminars, committees and private discussions, and so on." Such a response is natural in a person, who acknowledges new forms of knowledge and recognises the limitations of his old views in righting the wrongs committed in the name of development. This is a tremendous strength. If there has been injustice, Iyer says so without mincing words. As a result, he is not an apologist for the dominant paradigm of water or of the establishment. His candid critique of the approaches to water policy currently pursued by governments advances the need for fundamental reforms that will eventually help build human security.

Thanks to a pluralistic polity, local resistance to hegemonic practices exists in India. They include social movements, which oppose water projects that push implementation using the conventional paradigm. Not only have such movements raised questions about rights and risks, they have also contested the very meaning of development. Technophiles, however, will misread Iyer's arguments as 'anti-developmental'. This knee-jerk reaction is not surprising as simply it reflects the state of hegemonic paradigm espoused by the hierarchic solidarity, which disregards other forms of knowledge including those championed by markets and by egalitarian social auditors. It is the social auditors who contest the hierarchic forms of knowledge; and Iyer in his critique of the dominant form of knowledge, fulfils the role of a social auditor with aplomb.

Iyer's exposition helps readers understand the state of the State, in particular, how it is insulated, as well as why those in South Asia who seek a paradigm shift in water management need creativity both in argument and in the catalysis of change. His analysis

puts in perspective the reasons for the degree of reversal he highlights. The inertia can be explained by the dominance of the hierarchical approach which has its roots in South Asia's colonisation and capitalism's march in the Western U.S. in the early twentieth century, both of which form the context of the domain of knowledge production, education and the nature of the underlying politics of control of natural resources. Recourse to the same approaches will not work and new questions need to be answered. Some of these questions are: Who makes decision? Whose interests are reflected in the process? How should those processes be governed to ensure that the interests of all stakeholders are equitably reflected? How should disputes be resolved?

Ramaswamy Iyer's views as captured in *Water: Perspective, Issues and Concerns,* provide a glimpse of South Asia's contentious water regime in an era when both nations and people within nations face uncertainty and instability. A transition to a new but different societal order is underway but its characteristics are undefined. Iyer's treatise helps us see some of these uncertainities to chart out a suitable path for addressing the ills surrounding the region's water. For all its pronouncements about ensuring water security within the region, the practice of the conventional paradigm shows major shortcomings in fulfilling its intensions. Taps and canals in South Asia do not provide either safe or reliable supply of water and its rivers and lakes have been contaminated by untreated human and industrial wastes.[5] Groundwater shows the footprints of irreversible degradation caused by uncontrolled extraction.

Should such appalling conditions of water be condoned by South Asians who believe rivers as sacred? The condition of South Asia's rivers forces one to conclude that South Asians do not distinguish between spiritual and physical purity. Such an excuse would hardly be accepted as logical. They must question poor conditions and begin to nurture their waters collectively in order to build a social order in harmony with those surroundings that depend on water. The question is how can we move to that stage from the present one? In our quest for answers to ensuring water-related security for all citizens in South Asia, Iyer's book will be helpful in seeing through the inherent contradictions in the dominant water policy terrain.

NOTES

[1] These concepts are based on Paine (1988)

[2] See Iyer (1998)

[3] See Moench (2004).

[4] For discussion, see Bezanson (2004)

[5] A dramatic example is the Burhi Ganga River in Dhaka. Unabated dumping of toxic waste and untreated sewage has turned the river jet-black. see The Daily Star, 16 March 2005.

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