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Guidelines for Good Governance

Stage 1 Report

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Abbreviations

AMIS Agency-managed Irrigation System
DDC District Development Committee
DOI Department of Irrigation
FMIS Farmer-managed Irrigation System
FWM Field Water Manager
IMT Irrigation Management Transfer
IMTP Irrigation Management Transfer Project (Nepal)
PIM Participatory Irrigation Management
SIDD Self-financing/managing Irrigation and Drainage District
SMIP Sunsari Morang Irrigation Project
VDC Village Development Committee
WMS Water Management Station
WRB Water resources Bureau
WUA Water Users' Association
WUC Water Users' Committee
WUCC Water Users' Coordinating Committee
WUG Water Users' Group

Summary

Introduction

This review is based on reconnaissance study of 20 medium or large scale irrigation schemes and 4 large-scale schemes in north-west China, in order to get a comparative assessment of progress with participatory irrigation management. This covers a substantial proportion of the irrigated area in Nepal but a very small percentage of the area in China, where only 2 provinces have been studied. Further studies have been initiated in China to make this review more representative although it will still not reflect the full diversity of irrigation management in such a large country. This report will be updated on completion of these studies. Of the projects in Nepal, seven are agency managed, five are joint-managed, and eight are farmer-managed. Four are in the hills and the remainder are in the *tarai.*

Various forms of participatory irrigation management (PIM) have been introduced in many countries worldwide. Nepal and China have been at the forefront of these developments, but are both still endeavouring to find the methods best suited to their requirements. Early reports on water users' associations in Nepal (eg Gautam, 1989) were very positive and a complete project of over 10,000 ha was handed over to a WUA (Mishra & Molden, 1996). However, there have been considerable difficulties in sustaining these achievements. Although farmer-management has been successful on traditional schemes there has been much less progress in introducing it on modern irrigation, where it is hard to reconcile conflicting interests in heterogeneous communities.

Agricultural prices have been declining for some time, and Nepal has a policy of reducing subsidies, making production of cereal crops very unprofitable. Combined with a deteriorating political situation, the risks associated with agriculture have become very high. Off-farm employment, both locally and in India or the Middle East, have become increasingly important. The net benefit to irrigation is between £ 50 and £ 100 per hectare in Nepal. Higher benefits are typically only possible if fruit, vegetables or spring paddy can be grown. Irrigation is very highly subsidised, and farmers only pay a very small proportion even of the O&M cost. The benefits of irrigation are much greater in north-west China, typically £200 - £300, as yields are higher and it is a very arid region where agriculture is totally dependent on irrigation.

Objectives of Reforms and Progress

There are many reasons for introducing PIM. In Nepal the priority has been to improve the efficiency of irrigation investments and to decrease the governments involvement. These reasons also apply to China, where they also have the target of reducing total water use. In both cases the policy was developed by the Government with little participation by the users, who may have a very different agenda and less interest in taking on responsibilities which may increase their costs. WUAs have often been set up to meet the requirements for a rehabilitation or improvement programme, and the users have had less interest in their long term role. The concept of such organisations is rather different from traditional irrigation management, which was often rather autocratic, particularly on the larger schemes that are the focus of this study. It is evident that these new WUAs will need considerable support if they are to succeed, but it is not yet clear what are the critical factors or how long this support will be needed for.

Reduction in recurrent costs (by the Government) is an often stated objective but it does not appear to be realistic in the short term as the support required for new management systems is likely to be as expensive as the O&M that is saved. This should be offset in the longer term as a result of increased productivity, but until some gains have been achieved it is difficult to convince farmers of the benefits of management transfer. This is particularly true in Nepal where the yield increase with irrigation is small and dependent on many factors, which are out of the control of WUAs and users.

Although progress with transfer of management responsibilities has been slower than desired, participation has had an impact in improving the efficiency of management through incorporating local knowledge. This is much less than the empowerment that is desired but is nonetheless a significant achievement.

There is an extensive international literature on PIM, but there have been few formal evaluations and little evidence of a substantial improvement in irrigation performance. Even less has been documented on the impact of irrigation reforms on poverty. There is some concern that most of the benefits are captured by the elites, as they are able to dominate user organisations but preliminary findings from other studies suggests that the reforms will only succeed if these elites do taking a leading role. If they do so, then the general improvement in management will benefit the poorer farmers. This and the impact within households will be examined further in the detailed stages of this study as these are important unresolved issues.

Forest Users' Groups have probably had greater success in Nepal, but these too have needed long-term support and do not suffer from the more critical challenges which WUAs are faced with, where management is more complex and expensive and the benefits less direct. However, there may be lessons that can be learned from this process.

Performance of Water Users' Groups

Many people do not trust WUAs to operate honestly and transparently, and they consider them to be less democratic than local government (although multi-party democracy is also new to Nepal). There are rarely formal elections and it is generally rich farmers who dominate them. Conversely WUAs lack some legal authority to collect fees and carry out all their functions. There are several issues which appear to be critical to their sustainability:

- *Significant need for irrigation* – the social costs of community management are very high and farmers are unwilling to invest in this unless the benefits are perceived to be high, in the context of the local economy

- *Clarity and awareness of roles* – there is often a lack of definition or awareness of the objectives, and in some cases there is a disagreement over these. The relationship between WUAs, line agencies and local government is still not clear. WUAs are dependent on others who are responsible for main system management, but they have no recourse if they do not receive water on time.

- *Participation* – the extent to which the users participated in formulation of policy and the application of policy to local situation, their participation in the management institutions, how comprehensive this is for different sections of the community and different categories of users, and how well this reflects their interests.

- *Legal basis* – there must be an adequate legal base, not necessarily through a formally registered association but it must have sufficient authority to carry out its functions without being challenged in the courts.

- *Appropriate structure* - the WUA must be set up in a way that suits its objectives and the priorities of its members. Different projects have different requirements, and standard solutions tend to be over-complex or inappropriate for many cases.

- *Autonomy* – the ability to make independent decisions, collect and manage sufficient resources, , appoint staff and act in their own interests, rather than depend on external sources or influences is important, although they will need close relations with other agencies.

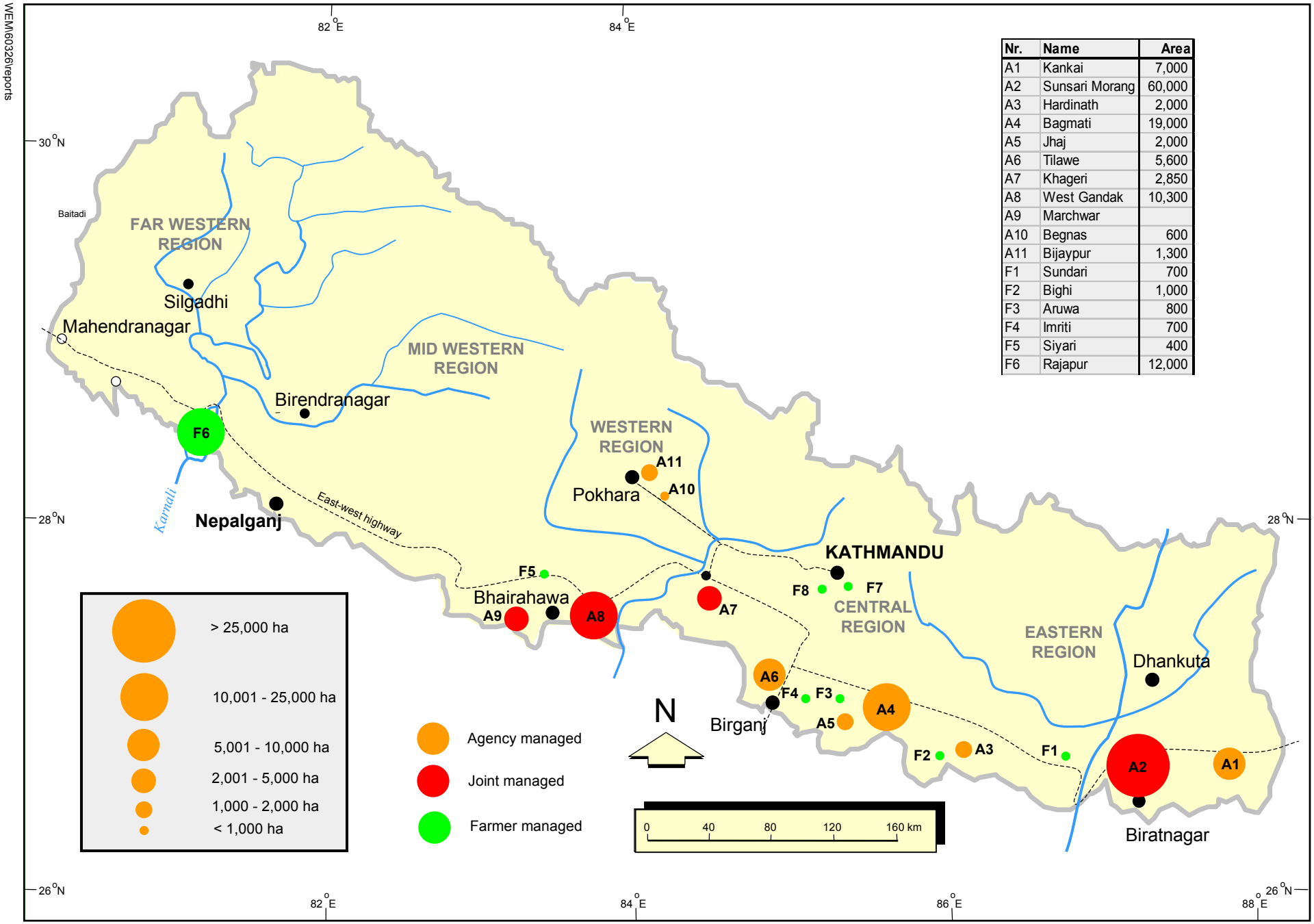
- *Accountability* – the organisation must be accountable to its members.

- *Transparency* – users often distrust WUAs, so it is essential that procedures, finances, distribution of water etc are fully transparent; traditional irrigation often has very transparent systems, but modern irrigation is not usually designed with this in mind.

The WUAs are just one part of the management system. In all large projects and many smaller projects the Government will retain some involvement for management of some components. They will also need to support the WUA. This may require some redefinition of roles and reorganisation of the Departments. This is already happening in Nepal, in the context of wider political reform and decentralisation. Specific measures related to irrigation management will need to be planned in this context. However, the deteriorating security situation and uncertain political environment in which local government has been dissolved will make it difficult to achieve significant progress in the short term.

The benefits of irrigation are quite low in many places – particularly in Nepal where it is used partly as an insurance against failure of the monsoon - and this will clearly influence whether the users are prepared to invest sufficiently in building local institutions. The remainder of this study will therefor focus on areas where there is a strong demand for irrigation and need for improved management – particularly where there is potential for increased dry season cropping or where conflicts are emerging over resources shared between several schemes.

As the study is being carried out in two countries it is important to transfer experiences from the two countries. The methods being adopted are remarkably similar, although the objectives and local context are different. In both cases these need to be carefully defined and reforms planned accordingly. China has adopted a policy of charging according to volume of water used. This is unlikely to be applicable in Nepal in the short term, but appropriate measures to ensure a transparent distribution do need to be found. Various different administrative structures and procedures have been adopted for WUAs in the two countries. There is a risk of developing over complex systems, and they need to be targeted on the specific requirements of individual schemes.



Nr.	Name	Area
A1	Kankai	7,000
A2	Sunsari Morang	60,000
A3	Hardinath	2,000
A4	Bagmati	19,000
A5	Jhaj	2,000
A6	Tilawe	5,600
A7	Khageri	2,850
A8	West Gandak	10,300
A9	Marchwar	
A10	Begnas	600
A11	Bijaypur	1,300
F1	Sundari	700
F2	Bighi	1,000
F3	Aruwa	800
F4	Imriti	700
F5	Siyari	400
F6	Rajapur	12,000

Figure S.1
Stage 1 Study Sites

1 Introduction

1.1 Purpose of the study

The purpose of this study is to identify methods to enable equitable and sustainable management of water resources by beneficiaries, with an improved poverty focus for water resource and effective input by poor farmers into policy formation. The study is being carried out in Nepal and China.

The outputs from the study will include:

- an inventory and review of schemes, covering performance, systems of management, conflicts, and constraints to reform;
- Recommendations for improvement in water management by reformed institutions, incorporating interests of poor farmers and indirect users as well as beneficiaries based on pilot studies in up to five schemes;
- Guidelines for good governance, which encompass the means to adapt rules and institutions to suit local requirements.
- Recommendations for national policy reforms

1.2 Purpose of this report

This report provides a summary of the first stage of the project, and is based on a rapid review of 20 projects in Nepal and 4 projects in China, supplemented by an inventory of all medium and large-scale irrigation in Nepal. It provides a summary of the progress in establishing participatory irrigation management and performance of water users' associations, and outlines the problems that have been encountered as a first stage towards identifying potential improvements.

The report is structured as follows:

- *Chapter 2:* a review of literature on irrigation management transfer, with a focus on Nepal and China.
- *Chapter 3:* Inventory of projects in Nepal and basis for selection of study sites for the initial review
- *Chapter 4:* Review of management on selected schemes in Nepal
- *Chapter 5:* Review of management reforms on selected schemes in China
- *Chapter 6:* Comparison of reforms in Nepal and China
- *Chapter 7:* Selection of Sites for the next stage of the study in Nepal
- *Chapter 8:* Conclusions

2 Literature Review

2.1 Context

The context for this review is the central research focus that user participation in management is essential for sustainable irrigation, but that the mechanisms for achieving this need to be developed further. Despite widespread programmes for transferring responsibilities for irrigation management, these have had much less little impact than desired. There is a need to identify more effective ways of involving users in management of large-scale irrigation, and this is the objective of this research. Despite the successes that have been achieved in some countries such as Mexico and Turkey, it has proved extremely difficult to develop effective and sustainable user organisations and transfer of responsibilities to these organisations has had little impact on poverty. This is confirmed by Vermillion's review (1997b) of studies of irrigation management transfer. However, in a more positive assessment by Johnson et al (2002), China and Nepal are two countries that have been highlighted as having made significant progress. Vermillion also noted the lack of rigorous and objective analyses of irrigation management, which makes it difficult to draw general conclusions.

Irrigation has been an important part of aid funding in the past, but this has declined because of disappointing performance (World Bank, 1995a). There is a high potential for improving management of existing infrastructure and thus enabling more efficient use of scarce water resources. It is no longer possible to consider irrigation in isolation, as resources are fully committed (or over-committed) in many places - all uses (or abuses) of water should be managed in an integrated manner. Transfer of water from relatively low-value agricultural production to municipal or industrial uses, and the impact of industrial wastewater on irrigation are now key issues. This is a major issue adjacent to urban centres, but even in rural areas there are many users of water other than irrigation and their interests also need to be considered. For example the 10,000 ha Kirindi Oya scheme in Sri Lanka also provides domestic water supply (from canals or via recharge to wells), water for livestock (50,000 cattle, 3,000 goats), fisheries in reservoirs, adjacent forest areas and downstream environmental flows (Bakker et al, 1999).

Social, institutional and financial rather than technical issues are now widely seen as the key to transforming under-performing, inequitable systems (Abernethy, 2001). However, this can be misleading as Plusquellec (2001) forcefully pointed out – many of the problems that farmers face revolve around how to manage poorly designed or maintained systems. We may know how to build them better now, but the issue is how to cope with and improve what already exists. In any case the technical problem is not solved until an appropriate way of managing the infrastructure is devised, and it may be necessary to make technical as well as institutional changes. It should also be noted that one of the few significant breakthroughs in irrigation in recent years – the rapid growth in private shallow groundwater development, particularly using treadle pumps – involved a technical innovation. Other possible innovations are portable drip irrigation and volumetric measurement of water flows direct to farmers. If these or other new technologies are developed, the institutional requirements would be very different from those applicable now.

There is a very extensive literature on these and related topics, although much information comes from project reports or brief research studies. This review is being prepared at an early stage in the research, and will be updated as the study progresses. A final version will be included in the final report in March 2004.

2.2 Impact of Irrigation on Poverty

Irrigation has been widely criticised for depending on an unreliable trickle-down effect for distribution of benefits. Many authorities (eg Barker & van Koppen,1999 and Hussain et al, 2001) nevertheless

state that irrigation has played a central role in poverty reduction even though most investment has focused on increasing overall production whilst giving little attention to distribution of benefits. However, this assertion has not been rigorously demonstrated, and for this reason two studies have recently been commissioned by ADB in five countries of Asia (Hussain et al, 2001) and by DFID in Nepal and Bangladesh (DFID, 2001).

Ownership of irrigable land is already skewed in favour of the rich, and through their greater political influence they are able to capture the greater benefit from new investment and a larger proportion of the available water. Despite this poor distribution, Barker & van Koppen (1999) still assert that the rural poor have gained in terms of enhanced food security and income. Their concern is not so much that they have not benefited, but that this benefit will not be sustained at a time of increasing water scarcity.

Barker also states that it is obvious that irrigation has a beneficial impact because the price of food has come down, which in turn benefits the poor. However, this ignores the impact of falling food prices on those smallholders who missed out on the direct benefits of irrigation - they grow rather than purchase their food and earn some cash from sales of their production but without the full benefit of increased yields to offset lower prices. Even the landless and urban poor who purchase their food may not benefit from lower food prices since unskilled wage rates are closely related to food prices (indeed they may even be paid in kind). Improved employment opportunities are the third main area of benefits identified by Hussain (2001). This may be generally true as there are few alternatives in most rural areas, but the situation is deteriorating since agriculture is often less profitable than other forms of employment: the returns to unskilled labour on winter irrigation are less than industrial labour rates in nearby towns (HR Wallingford, 2001).

Irrigation Management Transfer (section 2.4) is seen as one way of improving the impact on poor farmers (Johnson et al, 2002), yet Hussain et al (2001) have stated that successful IMT depends largely on the larger farmers, despite the implicit belief that user associations are more democratic and therefore should be more egalitarian. Van Koppen (2000) has also highlighted concern that IMT will have an adverse poverty impact. Most evaluations of IMT to date have focused on the broader issues of overall productivity (Vermillion, 1997) rather than the distributional impact, but there is some anecdotal evidence that IMT ensures a more equitable distribution of water and thus benefits the poor (Reidinger, 2002).

2.3 Irrigation and Gender

A number of studies of irrigation have also drawn attention to the role of gender in irrigation. The general view is that ignoring women's role in irrigation has reduced its impact (van Koppen, 2000) and there is little doubt that ignoring the different gender roles within the household has reduced the benefit of some projects (van Wijk et al, nd). Women are traditionally excluded from certain roles in agriculture – construction and maintenance of canals and ploughing being two key areas in Nepal – although shortage of male labour is breaking down some of these traditions. Women, however, contribute more than their fair share to irrigated agriculture as a whole, as well as using canal water for many other purposes.

These traditional roles make it difficult to involve women effectively in irrigation management, and in some cases, such as the Chattis Mauja scheme in Nepal, women even find their interests are best served by remaining outside the management system (Zwarteveen & Neupane, 1996). As they are not members, they are able to break the WUA rules without facing penalties: they rely on theft or informal arrangements (by personal contacts with canal leaders) and thus in this case they are well-served without having to contribute fully to maintenance. This is an unusual situation that favours women in the short-term but may undermine sustainability of the system since, with increasing male migration, more households will be headed by women in the future.

Positive discrimination is used to encourage women's involvement in Nepal but crude measures such as requiring a certain number of women to be on WUA committees, ignore the real issues and there is little evidence of such measures having a positive impact on any scheme in Nepal. For cultural reasons, women rarely participate in such meetings (Zwarteveen & Neupane, 1996). Van Koppen et al (2001) commented critically on one scheme (West Gandak) that had such a stipulation. Coincidentally, this was a project where there were other more fundamental deficiencies, which undermined the role of the WUA so it would be rash to draw many conclusions from this. Bruins and Heijmans (1993) report on the Bauraha project in Nepal, where women did not participate in design of the project, and found that it did not reflect their needs. This finding also needs some caution as it is not clear whether their demands (for an increased water supply, rather than the reduction in maintenance costs sought by men) were realistic. However, there is little doubt that women's participation in WUAs is very low in most if not all irrigation projects in Nepal, and measures to improve this situation have not been successful (Meinzen-Dick &Zwarteveen, 1997).

There are cases where women have been involved more effectively. Most reported cases come from Africa (eg Koopman et al 2001) and Latin America (eg Bastidas, 1999), and it is possible that this reflects are more conducive cultural environment as much as more appropriate techniques by the implementing agency.

2.4 Participatory Irrigation Management and Management Transfer

Introduction

Decentralisation, with devolution of responsibilities to the lowest practical level is widely regarded as essential for water management (following the Dublin Principles 1991). Irrigation management transfer has thus attracted considerable attention recently, with an email conference sponsored by FAO in 2001 attracting considerable support. This provided a great deal of practical information on the problems and processes, and highlighted the great difficulty in achieving effective and sustainable management by farmers on schemes previously managed by the Government.

Although the rationale for decentralisation is to improve management, the real motivation is often to save money for governments (Johnson et al, 2002). Even where management has been transferred effectively, the benefits of this may not have been equitably distributed. There has been some progress with local management at a very low level in the system but there have been significant problems in sustaining this progress.

There are many ways of transferring management responsibilities, but a common approach in much of rural South and East Asia is to form users' associations, or a hierarchy of associations and federations. Such groups are also widely promoted for a number of other purposes, such as rural water supply, community forestry, agricultural credit and so on. There are many parallels between such groups, but those that manage common property resources such as irrigation or forestry face the greater challenges. Even rural water supply groups do not suffer from the issue of 'free riders' to the same extent – free riders in domestic water supply schemes may compromise maintenance standards but they do not deprive others of water.

Although IMT has been widely adopted as a policy in many countries, there are many unresolved issues (FAO, 2001) and in most countries, including China and Nepal, there is as yet very limited experience. Many attempts at management transfer have been unsuccessful, resulting in less transparency, reduced resources, more conflicts and a spiral of physical deterioration and declining performance (Svendsen et al, 2000). However, external support applied sensitively is valuable (Kolavalli and Brewer, 1999) provided that it leaves sufficient flexibility for users to develop their own rules to develop institutions and govern them in a sustainable manner. Guidance is needed on how to do this. A recent FAO publication (Vermillion and Sagardoy, 1999) provides general guidance, and the World Bank have documented the start of the process in Andhra Pradesh (Oblitas and Peter,

1999). In many cases, these interventions have been imposed externally, often motivated more by saving money than improving efficiency.

Mosse (nd) provides a valuable perspective on the politics of water users' associations in a historical context, from Tamil Nadu. He notes that WUAs are likely to engender conflict over resources. In places where resources are now effectively channelled through WUAs, this puts them in conflict with traditional leaders, in a direct challenge to their authority – control of the institution became a more important issue than irrigation management. He cautions that a focus on traditional views of community may detract from the complexity of modern institutional innovation, and warns that programmes of water users' association development may have unrealistic and idealised objectives.

Farmer Managed Irrigation

There is a rich tradition of strong indigenous organisations for management of irrigation in Nepal, which has attracted considerable international and local interest (Pradhan 1989, Ostrom, 1992). These are often more successful than modern systems - they may face different requirements or challenges but performance is generally better than on comparable agency-managed systems (Lam 1998). FMIS have had a very varied history - some are recent but many date back over several hundred years and have often been enlarged significantly over time (sometimes with government assistance). In many cases, the area is extended by constructing a new parallel canal from the same river, forming an essentially independent system – this may seem inefficient but it is easier to manage. For reasons of technical simplicity and more importantly to reduce costs, these adjacent systems are often combined during modern rehabilitation problems. However, this creates problems of management which often remain unresolved.

It is also important to distinguish between purely indigenous organisations and those established on farmer-managed irrigation in response to external requirements before the Government will rehabilitate or build a system for the farmers. These imposed WUAs have had less success and often lapse soon after completion of construction – indeed locally many see their role as being more for rehabilitation than for long-term management which is a more mundane and politically less attractive task. Traditional systems often re-emerge as the real management organisation, but they may not have the skills required for the improved system and thus there is a concern that interventions will destroy the traditional management.

As noted above, groups of small FMIS are now sometimes combined into one with a single permanent headworks, to simplify maintenance. Lam (1998) is critical of this approach as he feels it undermines traditional maintenance arrangements, since the management organisation was developed specifically to mobilise the large amounts of labour required for maintenance of the intake. If the maintenance obligation is removed, the whole organisation may then fall apart and be unable to undertake the remaining management activities. This cannot yet be confirmed as the number and variability of schemes analysed is too small. However, even if the institution as a whole survives this challenge, it is faced with maintaining a modern headworks, which is usually beyond their capacity. This requires continued external support.

Well-defined rights are a feature of the successful schemes – a system based on investment in construction appears to be the most sustainable (Yoder & Martin 1996). There are restrictions on how close a new intake can be built above an existing irrigation intake, and given the leakiness of diversion structures this prevents many potential conflicts. Extension or other changes to established systems can be very divisive, even when planned and implemented entirely by the village (Howarth & Pant, 1987), although there are very successful examples (Yoder & Martin 1996).

There are some unsuccessful FMIS as well, but they may disappear with little trace into the rural landscape unlike AMIS, which leave concrete evidence of their problems. There are also many conflicts on these schemes that require mediation by external parties (Malla & Khadga, 1997, Khadga 2000). These are often related to disputes over rights to divert water from the river. Such disputes may

persist for long periods. Competing villages may develop amicable solutions at times of good social relations, only to conflict again as relations between individuals or villages deteriorate, possibly for reasons unrelated to irrigation (Pradhan and Pradhan, 2000). Projects which have worked for some time may face new challenges that they cannot respond to.

Despite these problems, farmer managed irrigation, mostly in small schemes, accounts for the majority of the irrigated area in Nepal (600,000 ha out of 850,000 ha surface irrigation according to Parajuli, 1999). Many have existed for generations and gradually adapted themselves as they face new challenges.

Agency Managed Irrigation

Traditional irrigation organisations, as described above, provide a valuable model for improving management on government schemes (Ostrom, 1992). However, there are many differences, and the concepts cannot be transferred directly. The fact that there are indigenous large-scale irrigation systems, such as in Rajapur (8,000 ha from a single main canal), does not mean that the same approach can simply be applied on Government schemes. For example, Rajapur functions by splitting the area into virtually autonomous units of less that 1,500 ha (Howarth & Lal, 2002). Little cooperation is required between these units, and there is a generous water supply.

AMIS usually differ fundamentally in both physical and social conditions. They commonly face scarce resources, are designed for centralised management and depend on cooperative management between unrelated users. Indeed the structured approach (often promoted by the World Bank) uses the reverse approach to FMIS. The structured system requires intensive management of the main and branch canals, as far as the outlets to the village canals where responsibility is handed over to the users (Perry & Albinson, 2002). The point of handover varies according to scheme, but is typically at the gate controlling supply to blocks of 1,000 ha. In a slight modification of the concept, some form of main canal joint management with the users is often practiced in Nepal. The lower level canals are either fully open or fully closed and thus management by the users is very simple in theory. Despite the simplicity, many farmers do not like this arrangement and often intervene in operation or even install additional gates, to increase operational flexibility, when participatory management is introduced (Shah 1998).

Some research into effective large-scale irrigation management has been done (eg in India, Wade, 1988), but this also does not yet provide models that can be directly applied elsewhere although it does highlight some important issues. These include the value of good leadership, understanding the benefits that arise from cooperation, use of village-based organisations, management of other common resources, understanding existing systems for managing conflicts, and defining clear relations between the state and users.

Following an analysis of FMIS, Ostrom (1992) identifies some rules to help establish new institutions:

- Service area boundaries and individuals with rights to use water should be clearly defined.
- Costs and benefits should be proportional (ie those who receive more water should contribute more resources).
- Physical conditions and user behaviour should be monitored by a group accountable to the users.
- Sanctions proportionate to the severity of the offence are imposed by users on those who break the rules.
- There should be easily accessible conflict resolution mechanisms.
- Users can define their own institutions.
- Large systems should be managed by nested hierarchies of institutions.

These guidelines provide a valuable basis for institutional development, although it does not appear that they have been effectively put in practice on a large scale yet. WUAs have been most successfully introduced on tertiary units and these have been reviewed by the World Bank (Salman, 1997 and Subramanian et al., 1997). Subramanian adds some further points which are seen to be important for establishing WUAs:

- New WUAs should build on existing community management arrangements as far as possible.
- Optimum sise of institutions depends on social characteristics, institutional structure and complexity of tasks to be undertaken.
- Leaders should be accountable to the members.

Despite the successes there are clearly still problems and even at a small scale, sustainability of new institutions is problematic. After early successes at Banganga in Nepal, the new WUAs completely lapsed in a few years (Pradhan, 1996). At a larger scale the impact has also been very limited. A review of large-scale management of irrigation by farmers in Sri Lanka found little impact (Samad and Vermillion, 1999). In the Philippines, long regarded as a pioneer in this field, the process of participatory irrigation management (PIM) is said to be at an impasse (Raby, 2000). The turnover programme for schemes serving less than 500 ha in Indonesia had little impact on performance, which was already high. It did not increase costs to farmers, but this was because maintenance was neglected and there appeared to be an underlying assumption that the Government will return to rehabilitate the schemes in the near future (Vermillion, 1997b). The main successes are in middle income countries, such as Mexico or Turkey (Groenfeldt, 2000). There is a very wide commitment to irrigation management transfer (INPIM, 2002), but as yet inconclusive evidence of its impact.

2.5 Irrigation Management Reform in China

There is some evidence of significant improvements being achieved in China (Feng, 2001 and FAO 2001), although there is very little literature available internationally and there does not appear to have been any rigorous independent evaluation. Assessment of the impact of institutional reforms is also complicated by the fact that there is often simultaneous investment in rehabilitation (eg World Bank, 1995, Li Ou et al, 2002), restrictions in supply or increases in water charges (Gau Hong, 2002).

Various different approaches have been tried in different provinces (MWR, 2002). One widely publicised approach is the concept of self-managed irrigation and drainage districts (SIDDs), which has been promoted on projects assisted by World Bank. These SIDDs comprise a company managing the main system and a series of users' associations managing tertiary canals. Simplifying the management structure, charging for water according to the volume actually used, and keeping fees collected within the system to be used for O&M are important features of this system. SIDDs are stated to be very effective and to have positive impacts on equity, as well as water saving and cost reduction (Reidinger, 2002).

Slightly different methods were adopted in Shaanxi (Johnson, 2001), where various arrangements were tested. At first private contractors were widely used, and this was reported as an example of private investors upgrading irrigation infrastructure. Contractors could achieve very good return on their investment ($12 – 65 / ha per year for an outlay of $2 - $65 / ha plus annual operating costs). Bhatia et al (2002), however, reported without details that there is a significant difference between the literature and the situation in the field. Now, however, this approach is no longer regarded as appropriate by the Chinese authorities as it results in privatisation, without compensation, of assets that were originally constructed by villagers. The reforms now promoted (Li Xiaokai et al, 2002) are much closed to the SIDD approach.

Johnson et al (1995) also reported on reforms in two irrigation districts in Hebei, each about 4,000 ha in area. These were part of wider rural reforms following the dismantling of People's Communes in

the early 1980s and were found to have led to effective local management and significant improvements in financial and agricultural performance. Key features were clear delineation of rights and responsibilities, and a linkage between payment of fees and receipt of water (with payment according to volume of water used). Sideline enterprises were found to be useful for retaining irrigation staff, by improving facilities and living standards, but where they are not possible greater external technical and financial support is needed.

The evidence on the impact of volumetric measurement is similarly limited. In general, flow is only measured as far as the turnout to WUAs who then allocate water on an area basis, with group pressure being regarded as effective in controlling water use (CCAP, pers comm, 2001). In some places, measurement down to individual farmers is achieved – for example in the Tarim Basin (HeHai, 2001). The transaction costs in measuring water use, collecting and accounting such fees are clearly high, and some do not consider it practicable (Lohmar et al, 2001). However it has further advantages in achieving very high transparency in water deliveries, and for this reason it is apparently very popular (Olson, pers com). This is based on short-term (2 years) experience in a small number (6) of WUAs in a very water-short region. It remains to be seen whether this model can be sustained and expanded.

Bhatia et al (2002) also reported on three other schemes (in Hebei and Jiangsu), where they found some improvements following the reforms, but considered that the overall impact is still very limited, with a large difference between theory and practice. Gau Hong (in MWR, 2002) has reported on the early stages of reform in Ningxia, finding a small improvement following introduction of WUAs and other reforms in 2000.

It would appear that pricing to reduce demand significantly would mean that charges have to be raised to prohibitive levels – and much higher than at present, where charges are based on actual costs of supplying water - in a situation such as North China where agriculture is totally dependent on irrigation. Nevertheless some progress has been achieved, although it is not yet clear whether this is due to control of supply, improved management within tertiary units, or reduction in demand due to pricing. Quite high collection of irrigation fees is obtained; this is generally considered to be because the charges are low (although they are very high in comparison with Nepal). Increases in charges have to be approved by the local Price Bureau whose role is to ensure that no distortions are created in the local economy and that local people are not caused undue hardship by the charges.

Given the dearth of objective data or independent evaluations, it is still only possible to speculate on the more subtle effects of irrigation management transfer, such as impacts on equity or poverty reduction.

2.6 Irrigation Management Transfer in Nepal

Although management on FMIS is always by the farmers, questions of transfer do still arise when the government intervenes since there needs to be a legally registered users' association before ownership can be transferred to the farmers. Early experience with government intervention was not very satisfactory, but this changed with the introduction of participatory techniques in the 1980s (eg ADB, 1999). It is a requirement of the irrigation policy that a water users' association should be set up before the government invests in such schemes. This requirement has played a very important role. New organisations often adopt a standard format rather than build on traditional arrangements. For this and other reasons the new association often functions only for the construction phase and then lapses rather than take on O&M responsibilities. There has been a lot of research in Nepal on farmer-managed irrigation, some of which has considered the impact of government investment in these schemes but there is still a gap in understanding of the best ways to intervene (or when not to intervene) and how to help farmers overcome the challenges that they face on FMIS (Pant, 1999)

There is less information available on management of agency managed irrigation, although there are various project reports. Most large scale projects now include introduction of joint management or

irrigation management transfer. The Irrigation Management Transfer Project has led to some independent research, notably by Khanal (2001). Panchakanya (600 ha) and Khageri (2,800 ha) are generally regarded as successful cases, with effective participation in rehabilitation planning and the early years after handover. Even here, there has been criticism of some aspects, and there are doubts over their sustainability (HR Wallingford, 2001).

West Gandak (10,300 ha) has been less successful (HR Wallingford, 2001), although early reports were optimistic (Mishra & Molden, 1996). With benefit of hindsight it can be seen that the problems should have been anticipated, but these were overlooked in the enthusiasm over achieving full transfer of a 10,000 ha irrigation project to the farmers. There was no clear definition of who was responsible for what, and how the resources required for O&M would be collected, since the direct user fees would be inadequate even if collected in full.

These programmes have required a very intensive effort in institutional development. It may be difficult in future to devote the same level of resources that were applied on the early schemes to all 200,000 ha in Nepal, and to support the schemes for a sufficient time unless government investment in recurrent costs is increased. The farmers are unlikely to pay the increased fees that are needed to cover these costs in the short term, since yields and output prices are so low (HR Wallingford, 2001).

This reinforces the need for objective evaluation of policies for participatory irrigation management before they are adopted too widely. Rehabilitation of large projects such as Sunsari Morang Irrigation Project (66,000 ha) has been combined with the introduction of the concept of joint management, although the original design was for centralised management - this makes transferring responsibilities more difficult and the impact has so far been small.

2.7 Governance of Users' Associations

A useful review of the issues surrounding governance of users' associations is presented by Osmani (2001). This raises a number of fundamental issues.

- The importance of a sound legal basis, since common resource management depends on strong regulation - there are cases of successful users' organisations achieving this without a legal basis, (such as that reported by Wade for large scale irrigation in India) but these are vulnerable to challenges by dissatisfied users, or to changes in policy.
- Comprehensive participation, including minority groups (through positive discrimination, if needed). This is for reasons of both efficiency and equity, and should include community assemblies, establishing reliable and adequate information flows, and ensuring that local knowledge is fully used.
- Organisations should be autonomous and able to generate resources internally (through local fees or taxes) rather than rely on central government grants. They also need to be locally elected, with independent staff.
- Accountability – eg through review of accounts in general assembly of members.

It is difficult to achieve this in practice, and real transfer from the centre or from local elites to democratically elected bodies is extremely difficult to achieve. There is a strong need for effective social mobilisation. NGOs can be useful in facilitating the transfer of power, but they may themselves be dominated by the same elites.

Anil Shah (1998) in an assessment of community-based natural resource management in India stressed the need for:

- Members to appreciate the short- and long-term benefits
- Disadvantaged members to have a position of dignity in the institution

- The institution to be seen to be fair and to observe its own rules and regulations
- Women to have a significant role; this may be best achieved by first forming separate women's groups who are then represented on the community group
- Continued (albeit diminishing) external support (both technical and financial) – for perhaps 7-8 years.

3 Inventory of Irrigation in Nepal and Selection of Study Sites

3.1 Nepal

3.1.1 Introduction

An inventory of medium- and large-scale irrigation projects in Nepal, indicates that there are about 80 projects that irrigate more than 500 ha in area and together they serve almost 300,000 ha, as summarised below. Over half of this area is in 7 large projects serving more than 10,000 ha each, but there are over 60 projects and 50,000 ha in the 500-2,000ha category. It should be noted that about two thirds of all irrigation in Nepal is in small schemes, of less than 500 ha, and mostly farmer-managed.

It should also be noted that most schemes visited under this study, particularly the farmer-managed schemes, were found to be much smaller in practice than in the official statistics. However, this may not represent the national situation as the sample is quite small, and it is also possible that some of the over-reported area is irrigated separately from other small schemes.

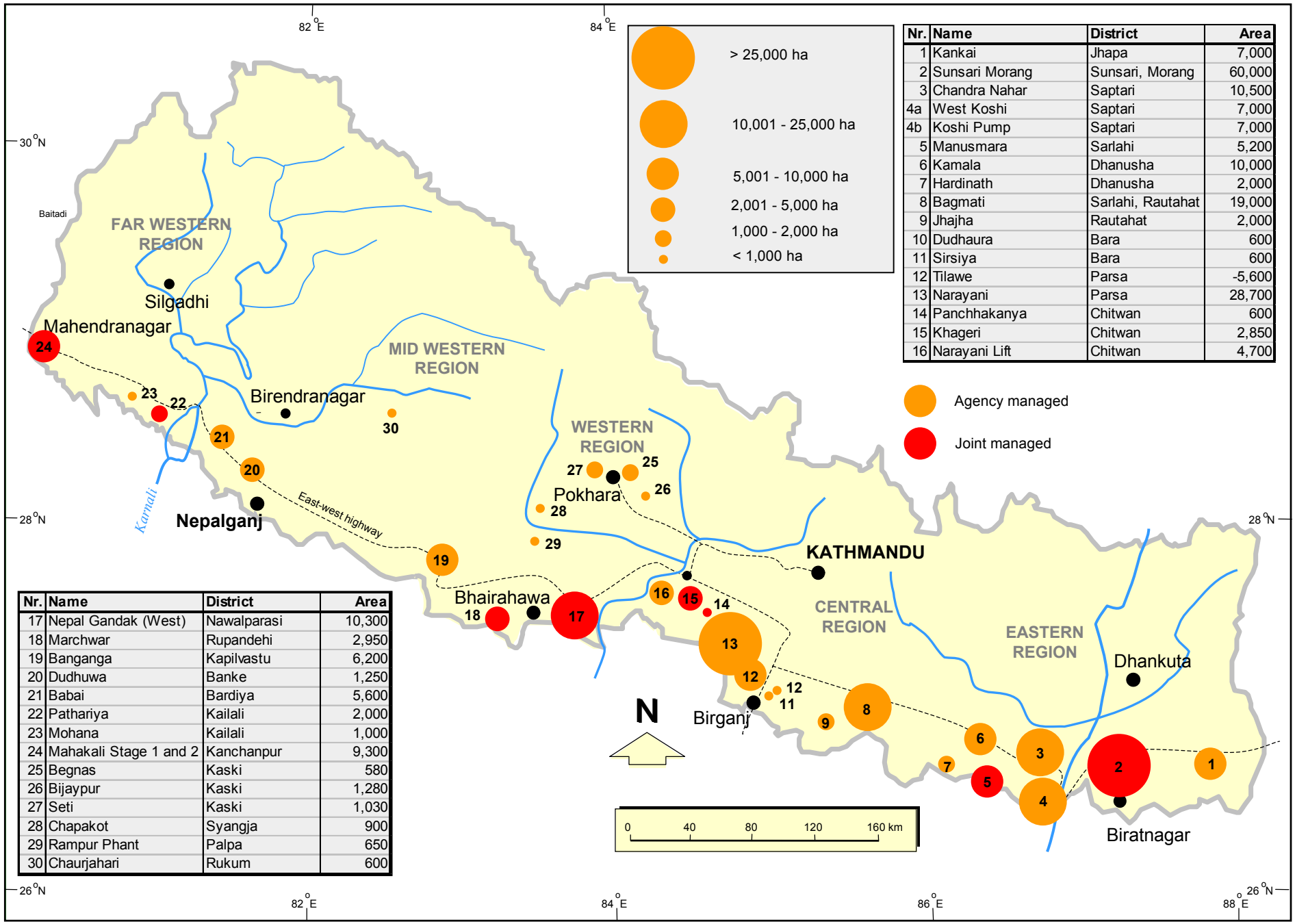
Further details on these schemes are presented in the summary table in Appendix A. This is a draft table, which will be updated as the study progresses.

Table 3.1: Irrigated Area in Nepal

Size (ha)	Nr	Total irrigated area (ha)	Management
>10,000	7	150,000	10% Farmer managed (1 scheme)
5-10,000	8	50,000	20% Farmer managed (2 schemes)
2-5,000	11	30,000	60% Farmer managed
1-2,000	16	20,000	60% Farmer managed
500-1,000	50	30,000	90% Farmer managed

3.1.2 Agency- and Joint-managed Systems

This review indicates that the number of AMIS in Nepal is quite small – about 25 in the *tarai*, including four very large schemes, such as Sunsari-Morang IP (Figure 3.1). There are about 10 small AMIS in the hills, although most of these are largely managed by farmers. Ten AMIS are included in the on-going irrigation management transfer project (IMTP). We reviewed two complete IMTP schemes in R7389 and had intended to review the third complete scheme in this study, but that has been delayed due to the security situation. The remaining IMTP schemes are in the process of rehabilitation and institutional strengthening and thus will be excluded from this project to avoid duplication of effort or conflicting methods. It is proving difficult to achieve effective and sustained transfer of management, and that is one of the justifications for this study. One IMTP scheme has been included in Stage I to provide comparative data. The schemes selected are marked on Figure 3.2

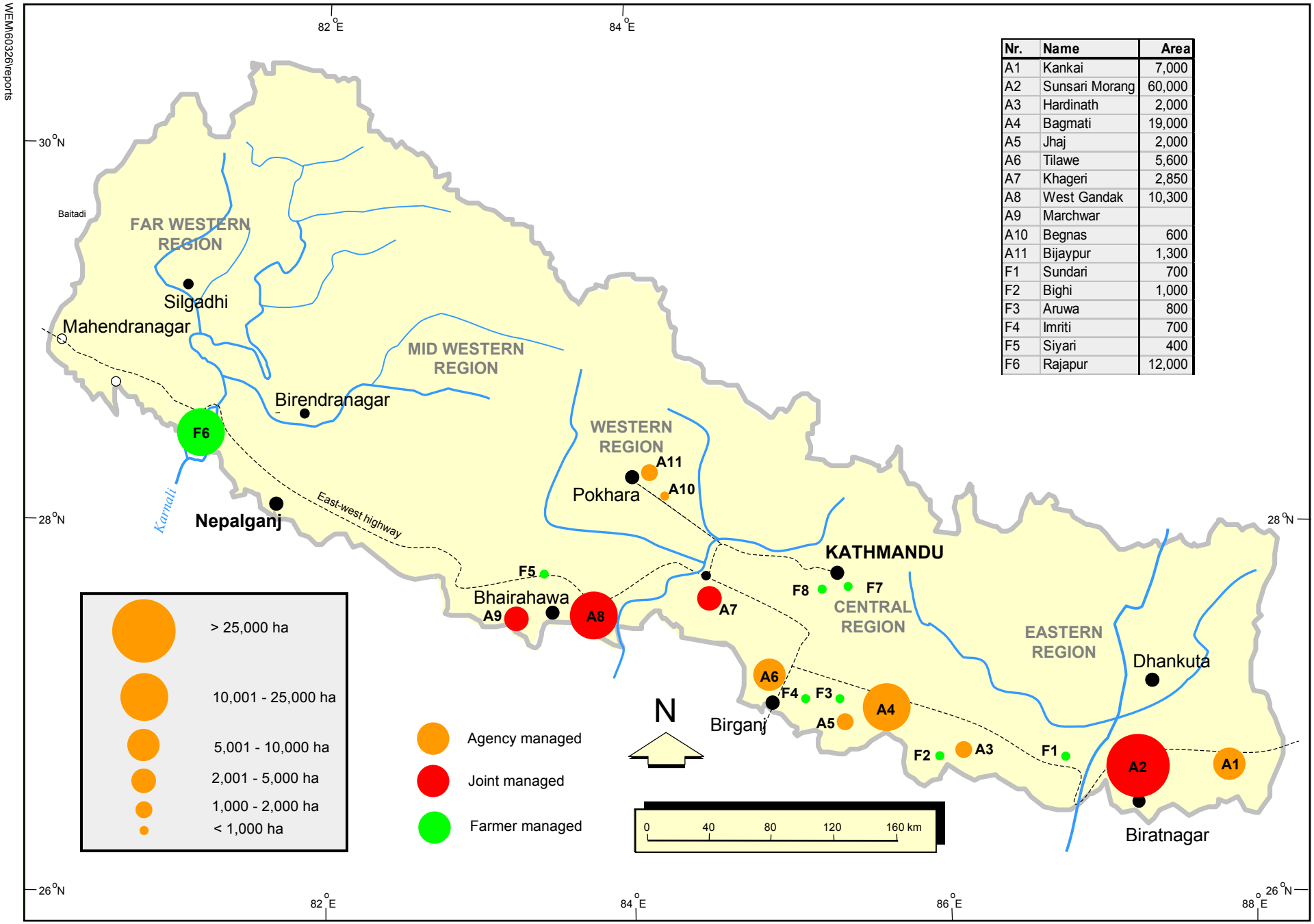


Nr.	Name	District	Area
1	Kankai	Jhapa	7,000
2	Sunsari Morang	Sunsari, Morang	60,000
3	Chandra Nahar	Saptari	10,500
4a	West Koshi	Saptari	7,000
4b	Koshi Pump	Saptari	7,000
5	Manusmara	Sarlahi	5,200
6	Kamala	Dhanusha	10,000
7	Hardinath	Dhanusha	2,000
8	Bagmati	Sarlahi, Rautahat	19,000
9	Jhajha	Rautahat	2,000
10	Dudhaura	Bara	600
11	Sirsiya	Bara	600
12	Tilawe	Parsa	-5,600
13	Narayani	Parsa	28,700
14	Panchhakanya	Chitwan	600
15	Khageri	Chitwan	2,850
16	Narayani Lift	Chitwan	4,700

Nr.	Name	District	Area
17	Nepal Gandak (West)	Nawalparasi	10,300
18	Marchwar	Rupandehi	2,950
19	Banganga	Kapilvastu	6,200
20	Dudhuwa	Banke	1,250
21	Babai	Bardiya	5,600
22	Pathariya	Kailali	2,000
23	Mohana	Kailali	1,000
24	Mahakali Stage 1 and 2	Kanchanpur	9,300
25	Begnas	Kaski	580
26	Bijaypur	Kaski	1,280
27	Seti	Kaski	1,030
28	Chapakot	Syangja	900
29	Rampur Phant	Palpa	650
30	Chaurjahari	Rukum	600

Agency and Joint Managed Irrigation

Figure 3.1

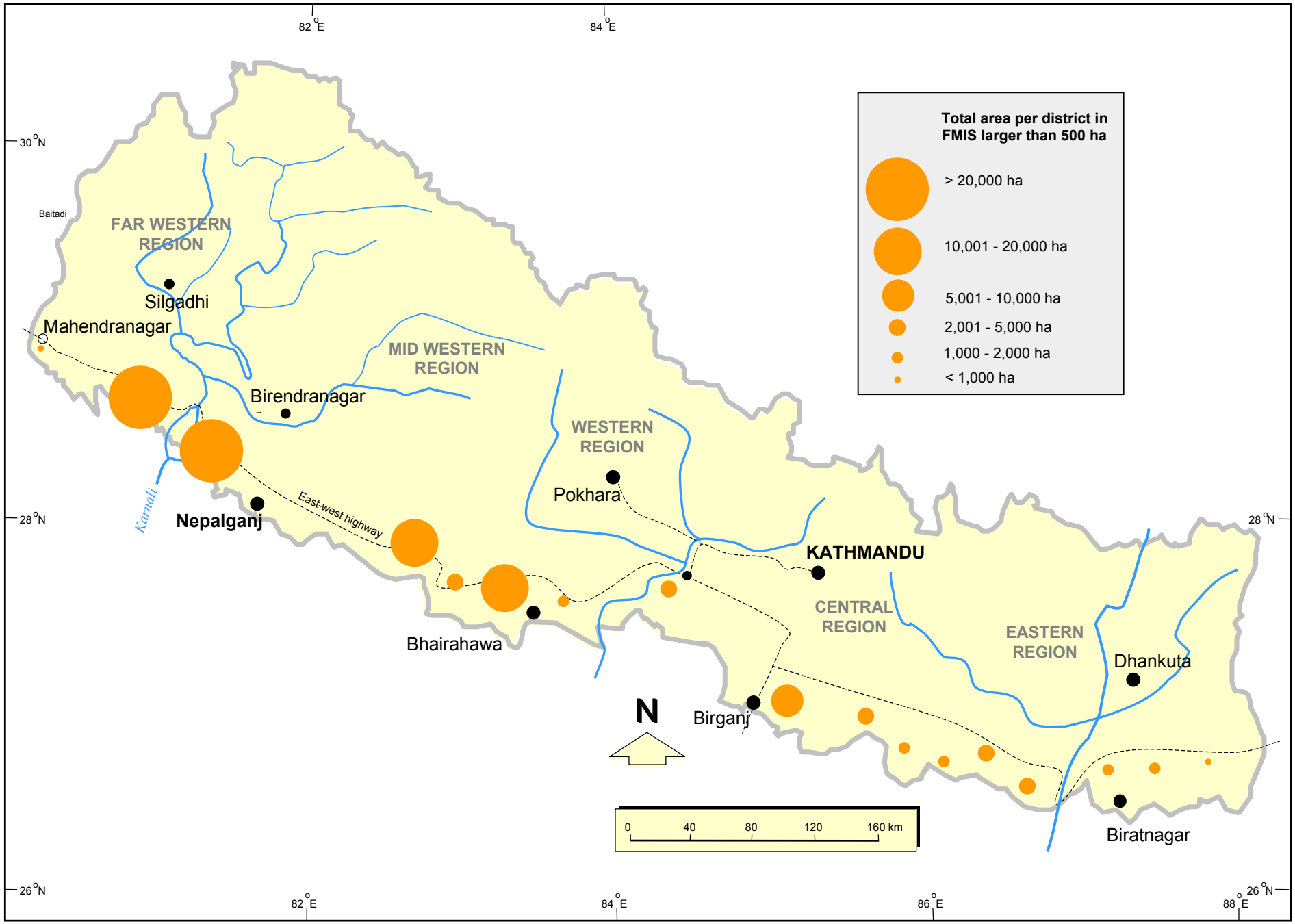


Nr.	Name	Area
A1	Kankai	7,000
A2	Sunsari Morang	60,000
A3	Hardinath	2,000
A4	Bagmati	19,000
A5	Jhaj	2,000
A6	Tilawe	5,600
A7	Khageri	2,850
A8	West Gandak	10,300
A9	Marchwar	
A10	Begnas	600
A11	Bijaypur	1,300
F1	Sundari	700
F2	Bighi	1,000
F3	Aruwa	800
F4	Imriti	700
F5	Siyari	400
F6	Rajapur	12,000

Figure 3.2
Stage 1 Study Sites

Table 3.2: Agency and Joint Managed Irrigation in Nepal

Project	District	Area(ha)	Notes
Gravity Irrigation			
Kankai	Jhapa	7,000	1,200 ha turned over in 2000
Sunsari Morang	Sunsari, Morang	60,000	rehab in progress – joint managed
Chanda Mohana	Sunsari, Morang	(1,800)	new – under construction, overlaps SMIP
Chandra Nahar	Saptari	10,500	in process of turnover
West Koshi	Saptari	7,000	13 canals from Koshi Main Canal (India)
Manusmara	Sarlahi	5,200	turned over 2002
Kamala	Dhanusha	10,000	in process of turnover
Hardinath	Dhanusha	2,000	in process of turnover
Dudhaura	Bara	600	
Sirsiya	Bara	600	
Narayani	Parsa	28,700	supplied from India, actual area may be less
Tilawe	Parsa	(5,600)	semi-independent part of Narayani
Khageri	Chitwan	2,850	turned over 1996-99
Panchhakanya	Chitwan	600	turned over 1996
Nepal Gandak (West)	Nawalparasi	10,300	turned over 1998; barrage managed by India
Banganga	Kapilvastu	6,200	in process of turnover
Dudhuwa	Banke	1,250	
Jhajha	Rautahat	2,000	
Bagmati	Sarlahi, Rautahat	19,000	construction in progress
Babai	Bardiya	5,600	construction stopped – boundary river dispute
Mohana	Kailali	1,000	in process of turnover
Pathariya	Kailali	2,000	turned over 2001
Mahakali Stage 1 and 2	Kanchanpur	9,300	new – joint managed
Lift Irrigation			
Koshi Pump	Saptari	7,000	pumped from Koshi Canal (serving India)
Narayani Lift	Chitwan	4,700	
Marchwar	Rupandehi	2,950	new / turned over 1998-2000
Hill Projects			
Chaurjahari	Rukum	600	
Tika Bhairab	Lalitpur	400	
Begnas	Kaski	580	
Bijaypur	Kaski	1,280	
Seti	Kaski	1,030	
Chapakot	Syangja	900	
Rampur Phant	Palpa	650	



Large-scale Farmer-Managed Irrigation

Figure 3.3

3.1.3 Farmer-managed Systems

There is a much larger number of farmer-managed schemes, although these schemes are generally much smaller than AMIS. About 50 are more than 500 ha in the *tarai* and 25 more than 250 ha in the hills, but it should be noted that areas are often over-reported in official statistics. The location of these large schemes are indicated on Figure 3.3. Comparison with Figure 3.2 suggests that government-managed schemes have been built in places where the farmers had been unable to develop irrigation. There could be many reasons for this, but it means that new large-scale irrigation ahs been developed in areas where there is little tradition of irrigation management.

These schemes include many built with government assistance but now managed by farmers as well as farmer-built schemes. Most, perhaps all, schemes have had some external assistance at some stage – sometimes initiated by the farmers, on other occasions stimulated more by the existence of an external programme. The eight schemes discussed here are Sundari, Bighi, Aruwa, Imriti, Siyari, Tika Bhairab, Mahadev *khola*, and Rajapur.

3.2 China

Two regions in China have been visited: Xinjiang and Ningxia, both are in the north of the country and are characterised by extreme climates which mean that only one crop can be grown each year. Both are desert regions and totally dependent on irrigation.

In Xinjiang, the Tarim and Manas River Basins were visited. There is a World Bank assisted project in the Tarim, through which Self-managed Irrigation and Drainage Districts (SIDDs) have been set up following the pattern established earlier in the Yangtze Basin (Reidinger, 2002).

4 Irrigation Management in Nepal

4.1 Management Types

The complex construction and management history of projects makes the simple division into AMIS and FMIS used above somewhat misleading, and thus some clarification is necessary.

Agency management – either a project office or a District Irrigation Office employ staff to manage the project, including operation of structures and maintenance of infrastructure. At some point they deliver water to a users' group or directly to users. There may be some involvement by users or users' groups at higher levels in the system, either on a formal (joint-management) or *ad hoc* basis.

Farmer management – formal or informal users' groups, or a hierarchy of such groups manage all or part of a system. There are one or more points of transfer of responsibility (or activity) for management.

The following scenarios are possible:

- Agency built and managed (eg Narayani, Tilawe, Jhaj), possibly with informal involvement by farmers or users' groups in aspects of management (especially tertiary canals)
- Joint management - agency built and managed, excluding tertiary canals managed by formally registered users' groups (eg SMIP)
- Joint management - agency built and managed, excluding secondary and tertiary canals managed by formally registered users' groups (eg Khageri)
- Turnover - agency built, formally handed over to farmer-management in accordance with Irrigation Policy (eg Marchwar, West Gandak), (these may still retain significant involvement by DOI)
- Agency built, informally transferred to farmer management (eg Pithuwa)
- Agency built for farmer management (many schemes in recent ADB and WB sector programmes)
- Farmer-built, agency managed – usually associated with extensive rehabilitation or enlargement (eg Babai, Begnas)
- Farmer-built, agency rehabilitated, farmer managed – often retaining significant involvement by DOI in management (particularly those structures built or rehabilitated by DOI) (eg Mahadev *khola,* Bighi, Rajapur)
- Farmer-built, farmer managed (eg Rani-Jamara).

The process of government intervention in Rana and earlier periods (pre-1950) is so different from current government activities in the sector that projects built with Government assistance at that time are regarded for this study as farmer-built. Most remain farmer-managed, but some have been taken over by the Government.

The Village Development Committee (VDC), which is the lowest level of local government has some role in irrigation. They are not normally formally involved since management of irrigation at a local level is the responsibility of water users' associations, but the Local Governance Act of 1999 gives certain responsibilities to them for planning and implementing projects as well as resolving dispute. The VDC may assist, for example, financially and with conflict resolution. The District Development Committee (DDC) also has responsibilities for planning, implementation and management of irrigation projects covering more than one village.

4.2 Agency-managed Irrigation

4.2.1 Introduction

This section is based on brief field studies in the following agency-managed irrigation schemes in January - March 2002, with the exception of Kankai which was studied in 2001. The schemes were generally not in operation at the time, and thus the conclusions are based on indirect data and discussions with users and other key stakeholders. The schemes studied were:

- Kankai
- Bagmati
- Tilawe
- Begnas
- Hardinath
- Jhaj
- Bijaypur

4.2.2 Status of Systems

The schemes cover the full range of agency-managed schemes, ranging from 600 to 37,000 ha. (600 to 1,300 ha in the hills and 2,000 to 37,000 ha in the *tarai*). WUAs have been formed on all schemes, with varying degrees of impact. All these schemes should be joint-managed, but the process is not yet far advanced and thus they are regarded as agency-managed in this analysis. All WUAs are formed in the standard hierarchy to suit the canal layout, although not all levels have been formed in some schemes. Hardinath is included in IMTP and is thus in process of rehabilitation of rehabilitation and institutional development, following which it will become joint-managed. The comments below relate to the current situation, which can be expected to change soon.

The physical condition is similarly variable. The larger schemes (Kankai and Bagmati) are usually in better condition as they are the responsibility of special project offices and thus attract greater government finance. The smaller schemes are the responsibility of District offices, which are less well funded and have other responsibilities. Funding and hence maintenance activities are low and vary from year to year on these schemes. The tertiary-level canal network is also less well developed. Tilawe is a small system with supplies augmented from the Narayani project, a very large system mainly serving India. Both, however, are in poor physical condition. Both Narayani and Kankai have recently been transferred from project to district offices, and users report this has led to a deterioration in condition and performance, and a reduction in funding.

Water is scarce on all schemes, except Kankai. This means that part of the official command areas receive no water or only limited supplementary irrigation during the monsoon. Kankai has sufficient water for perennial irrigation on half the total area, and a system whereby each secondary canal receives water in alternate years is enforced by DOI. Elsewhere there is no formal system of rotating dry season supplies over the whole command area, and water is only available to head-end or other privileged areas. In some cases, the canal system is not appropriate for dry season irrigation (due to inadequate control structures to manage low canal flows, or lack of tertiary and field canals). This applies to most of the un-rehabilitated older schemes.

Control structures are generally gated; these are often in poor condition, except in the new or newly-rehabilitated projects (Bagmati and Kankai). The modern schemes are usually designed with a logical hierarchy of canals. Some of the earlier schemes were developed in a less logical order since the main canals were built first, many years before command area development. By that stage there was a mixture of semi-formal arrangements built by users and project offices. This is most pronounced on the medium-scale projects such as West Gandak and Banganga (reviewed during R7389). All schemes were designed on the assumption that all infrastructure built by the government would be operated and maintained by a government agency.

Maintenance of the main system is always by the DOI. Users are sometimes involved in tertiary level maintenance on an informal basis, and take full responsibility for quaternary (watercourse) and infield maintenance. They rarely intervene in main system maintenance – either in planning or implementation - except as paid workers.

Table 4.1: Status of AMIS Studied

Project	Area	Date of construction / rehabilitation	Control		Standards of Maintenance
			Main	Tertiary	
Kankai	7,000	1990	Gated	Gated	Good
Bagmati	37,000	On-going	Gated	Gated	New
Hardinath	2,000	2002	Gated	Gated	New
Jhaj	2,000	1965	Gated	Gated	Poor
Tilawe	5,600	1994	Gated	Gated	Poor
Begnas	600	1990	Gated	Gated	Fair
Bijaypur	1,300	1966	Gated	Gated	Fair

4.2.3 Socio-economic characteristics

The following tables provide some comparative social data on the projects. This is very approximate and is intended mainly to provide a context to review the different schemes. It was based on a rapid reconnaissance and some of this information is sensitive - farmers are often reluctant to reveal information on land ownership and there are many different possible arrangements. The classification by ethnic grouping is also simplified and contentious, but has been done to highlight some key differences between schemes.

Table 4.2: Ethnic Composition of Projects

Project	Tharu	Yadav	*Tarai* Brahmin	Hill	Other
Kankai				80	20
Bagmati	30		60	10	
Hardinath		60	5		35
Jhaj		50	5		45
Tilawe		35			65
Begnas				100	
Bijaypur				100	

Table 4.3: Educational Status

Project	% Adults who have attended school	
	Male	Female
Kankai	na	na
Bagmati	50	25
Hardinath	75	25
Jhaj	20	5
Tilawe	20	10
Begnas	95	85
Bijaypur	80	70

Table 4.4: Land Tenure (among Water Users)

Project	Landlord (non-cultivator)	Owner cultivator	Landless cultivator
Kankai	2	95	3
Bagmati	10	80	10
Hardinath	5	85	10
Jhaj	10	80	10
Tilawe	5	75	20
Begnas	5	90	5
Bijaypur	5	80	15

Table 4.5: Cropping and Irrigation Intensity

Project	Annual Crop %	Irrigation %	
		Annual	Spring
Kankai	190	185	60
Bagmati	220	150	0
Hardinath	205	175	0
Jhaj	200	110	0
Tilawe	200	185	0
Begnas	170	115	0
Bijaypur	290	250	60

4.2.4 Governance of WUA

(i) Basis for Formation of WUA

The WUAs were all set up by DOI to meet the requirements of the irrigation policy. Older WUAs (such as Tilawe) were set up and registered in accordance with the Associations and Organisations Registration Act (1977). Simplified procedures have now been set up in accordance with the Irrigation Regulations (1999); these do not require annual renewal.

Most of these projects were set up by DOI as agency-managed projects with no user-participation, thus there was no indigenous organisation to build on when planning participatory management. Some (Hardinath and Begnas) were set up to combine and enlarge older FMIS, with a view to simplifying operation and increasing the command area. However, the construction was so long ago and village management systems have changed so much since then that there is no possibility of reviving or strengthening the original management. Kankai is the only one which was initially developed after the concepts of participatory development were introduced to public sector irrigation in Nepal. WUAs have existed for some time, but even here they were introduced at the instigation of DOI with little involvement by the users.

On the large schemes (such as Tilawe, which is part of the Narayani scheme), water users' groups at outlet or tertiary level were set up first and then these were built on to form higher level users' associations or coordinating committees. This process is still in progress at Bagmati, where the main system WUA has yet to be formed. The reverse approach is followed on the smaller schemes, starting with the high level committee and using this to help establish the low level groups.

The immediate motivation for forming the groups has usually been to improve participation in rehabilitation and hence the efficiency of this investment. Such programmes are generally long term and absorb most of the available resources, so that the WUAs are not so well developed for their longer term management role. In some cases, such as Bagmati, they were established after rehabilitation. This has been a much less effective approach as can be seen by comparing the performance of the third stage of SMIP with Bagmati Irrigation Project.

In the more recent schemes, there was some training and awareness-building at a relatively early stage so that there was some understanding of the irrigation policy, the legal requirements for associations, and the reasons and the implications of this policy. Less preparatory work was done on the other schemes, and it is apparent that many users and even WUA officials are unclear of the purpose. There is little evidence of either demand to take over management responsibilities or recognition by the users that WUAs are intended for this purpose.

In one case, Hardinath, the concept of WUAs was originally promoted through the VDCs by the DDC representative for the area. This WUA operated on an informal basis until the project was adopted by IMTP when an intensive programme of social mobilisation was begun. On the remaining projects, the other WUAs are still being set up, as a prelude to establishing joint management.

(ii) Definition of Functions of WUA

According to the irrigation policy, all these projects should be managed jointly since they are more than 2,000 ha in the *tarai* and 500 ha in the hills, but this has not yet been formalised. There should be project-level coordination committees to liaise between WUAs and the project but in practice the high level WUAs, where they exist, still act as informal coordinating bodies with the government.

The policy requires that these WUAs should be autonomous and responsible for operating, improvement, maintenance and renovation within defined blocks, and the irrigation office is

responsible for the upper parts. There should also be a coordinating committee of the WUAs at project level, although the responsibilities of this committee are not defined in the policy. The policy is mainly concerned with procedures for implementation (construction and rehabilitation) and does not cover long-term management in any detail.

The irrigation regulations (1999) expand on the role of the users' association as below. The role of the coordinating committee is not elaborated and the responsibilities of the project office are only defined as to determine the priority order for distribution of water, in consultation with the District Agriculture Development Office, if the demand can be satisfied.

- Maintenance, operation and management of the component it is responsible for, including mobilisation of labour for maintenance
- Provide water in appropriate time and quantity to users, without harm to other users
- Keep records of land that is not irrigated, so that ISF can be exempted
- Construct additional structures to increase the irrigable area

The regulations also lay down procedures for setting fee levels and managing finances, and the proportion that should be paid to the government for main system management is covered in the policy.

The WUA constitutions generally restate these functions and, when established at the time of a rehabilitation programme, also include responsibilities for construction and rehabilitation. For example, in the case of Hardinath, these include assistance in planning, mobilising 'voluntary' labour contributions and assisting in supervision of construction. This is fairly well defined and implemented when there is an ongoing construction programme, but on some projects the WUAs see their main function as a pressure group for maximising government investment and feel that they have failed if they are unsuccessful in this role. This has undermined the WUAs at Bagmati, but this weakness is more due to a misinterpretation of their function.

Once construction is complete, the role of the WUA is very limited since they see the government as being responsible for management. It is apparent on most projects that WUA members are generally unable to define clearly their responsibilities for routine O&M. These schemes are all in a state of transition, but there is clearly a risk that they will remain in this state even after management transfer.

(iii) Clarity of Roles

There needs to be a clear division of responsibilities between agency and users' associations, different levels of WUAs, and between WUAs and users. Furthermore failure of management at one level will affect management at other levels. Thus quality criteria are also needed, particularly with regard to water distribution. These are difficult to define since the availability of water in the source is both unreliable and unpredictable in these schemes.

Until there is a formal joint management agreement, the tertiary level WUAs have no legal responsibility and are unwilling to take on any tasks, such as maintenance and they are effectively acting outside the scope of the Irrigation Policy. This explains the very low level of activity at Hardinath, Bagmati, Jhaj, Tilawe, Begnas and Bijaypur. Existence of a formal agreement does not necessarily mean that the WUAs are more active, but they do appear to be more effective at Kankai.

The Local Governance Act (1999) gives the VDC certain responsibilities for management and dispute resolution, which can be seen to overlap with the WUA – particularly if the VDC invests in the project. This however, does not appear to be such an issue on AMIS as it is on FMIS, since the users defer to the project or DIO. This has to take account of VDC pressure but they are better able to resist such influences than are the users. None of the agency-managed projects studied regarded VDC pressure to be a problem, although some WUA members are also VDC members. That is not

surprising since the number of individuals suited to community posts is quite small and a large proportion of these may be members of the VDC.

The WUA committee members may also manage maintenance of the main canals under contract to the project office and employ the users on this; this sometimes causes mistrust between the committee and general membership. This is a legitimate way of involving the users in the joint-managed parts of the system, but it is not very transparent and so it affects their ability to manage the lower levels of the system.

At Hardinath, the WUA is focused strongly on ongoing rehabilitation and pressing for additional works before it is prepared to sign a joint management agreement. Disagreements over the scope and quality of works continue to cause dissatisfaction, and the role of the WUA will remain ambiguous (without any formal responsibilities for O&M) until these are resolved. This is a common consequence of combining management transfer with rehabilitation.

The WUAs were set up about 10 years ago at Tilawe, but have no formal role since the project has not yet been handed over. A prolonged strike after transferring responsibilities from central to district level has disrupted operation so much that the WUAs are effectively non-existent. The strike has now been resolved, but the WUAs are still non-functional and it will require considerable effort to reinstate them.

The new WUAs (Jhaj, Begnas and Bijaypur) work as liaison bodies for management of the main system, without any formal responsibilities. This is true at Kankai also, but some secondary WUAs there do have a specific responsibility for maintenance.

(iv) Appropriateness of Organisation and Awareness of Responsibilities

Organisational arrangements for all these WUAs are fairly standard, regardless of the type or scale of project – typically a chairman, vice-chairman and seven members for each WUA. Where there are several tiers, the chairmen of the lower level groups are nominated as members of the high level WUA, and the chairman of the higher WUA is directly elected from the general assembly of all users. A common format may be reasonable since most of these projects have broadly similar requirements for O&M and face similar pressures (eg water stress, deteriorating infrastructure, limited funding, weak main system management), but this approach is both more bureaucratic and democratic than that traditionally adopted. However these systems have few traditional skills in irrigation management that they can build on, and all of a scale that makes it impossible for any other existing community management organisation to take on irrigation as well.

They differ slightly in the way they interpret their responsibilities and for example in the role that they leave to the VDCs. In most cases they seek to exclude local political influences (or more specifically inter-party disputes) and this is seen as an important requirement by those who help establish WUAs. However, locally influential people are generally included to give the WUA some credibility and enhance their ability to influence government agencies. In some cases, prominent individuals from the tail of the system are purposively involved since they are seen as the most likely to be effective in ensuring a good water supply.

As noted above, many WUAs interpret their main responsibility as being to assist in rehabilitation and construction management, and demand additional resources to maximise the amount of work that is done. Once this stage is complete, they either lapse or seek to attract further external resources, from sources such as DOI as well as VDC and MPs grant allocations. This is an important role, which can enhance the viability of the WUAs, but it may undermine their ability to collect their own resources and is not reflected in their constitutions.

One of the first acts of the new WUA at Jhaj was to attempt to gain control over the *sissoo* trees growing on canal banks, since these are a valuable resource. By contrast, their main tasks (see above) are relatively neglected. The most active WUAs see their role as to mobilise unskilled labour for maintenance of small canals; none are able to raise significant amounts of cash.

(v) Data and Management Systems

The Irrigation Regulations require the WUA to maintain records, including data on service charge collected, and to submit an annual report including activities and financial data. None of the maintain adequate records or have strong administrative systems – or indeed any formal system - and most lack the basic data with which to manage the irrigation. For example, none has a complete database of members or beneficiaries, which clearly makes it difficult to collect resources. Most WUAs keep a minute book in which they record attendance and decisions taken at meetings, but few other records are kept. These systems are being set up at Hardinath.

WUAs only have separate offices if these are provided by the project, as the cost of rental is too high, and thus records are kept in the chairman's or secretary's house. No systems are in place on those schemes where the WUAs are newly established (Jhaj, Begnas and Bijaypur). A fairly comprehensive arrangement was set up at Tilawe, but this has completely lapsed since the DOI withdrew from the project. Rather than stimulate the WUA into taking over more functions, the impact of the withdrawal by DOI was a partial collapse of the system. This reflects the low importance of irrigation in the local economy and the very weak condition of the WUAs at the time of withdrawal by DOI.

(vi) Financial Management and Transparency

These schemes are agency-managed and thus the WUAs do not have financial resources. As WUAs have recently been set up and these schemes are moving towards agency-management, they are nominally collecting fees - at the national standard rate of Rs 120 per hectare. The actual collection is very low, with usual reason given being that no penalties are imposed on defaulters (who are often the richer farmers, and may even be WUA committee members), so that fewer farmers are prepared to pay in future years. At Kankai, the WUA reported that farmers are unwilling to pay since the fees were mainly used for administration. The fees are so low that they are quite inadequate for any maintenance and cover little more than the transaction costs involved in collecting them. The maintenance that they were required to do was mainly in the form of unskilled labour, so the users see no need to pay.

On most schemes at least one tier of WUA keeps a bank account. In some cases, they are jointly managed with the District office – many users prefer this arrangement as they have more faith in it. These are audited and in some cases (Hardinath) discussed at annual general assembly meetings. At Hardinath two accounts are kept, one by the WUA alone and one joint with the DIO. In most cases, some funds are built up at the time of rehabilitation, but none of the WUAs are able to sustain collection of fees for O&M.

There are stronger systems for collecting contributions to maintenance (as grain or labour) on many FMIS, with penalties for defaulters. These are much less common on AMIS (and purely informal) but they have been continued on Begnas, which was originally an FMIS.

(vii) Autonomy

None of WUAs is genuinely autonomous and accountable to their members. Local leaders are very influential, and many users want to be represented by people who they think will be best able to attract resources to the project. They may be elected members of the WUA or they may influence it indirectly so that decisions are made in accordance with traditional practice rather than with WUA constitution.

This is also true of many FMIS and is as might be expected given the history of irrigation and cultural dynamics in Nepal.

4.2.5 Performance of Systems

(i) Introduction

This section reviews the overall performance of the schemes in qualitative terms and distinguishes between the performance of the WUA and the agency responsible for main system management. Formal data on these issues will be collected by direct observation on selected schemes in stage 2 of the study.

(ii) Quality of Maintenance

The only maintenance that any of these WUA does is to manage unskilled labour for canal cleaning at tertiary canal level or below. This is a very simple task, and requires little coordination of users. Maintenance at field channel / watercourse level is generally adequate but tertiary canals are often badly maintained or left to DOI. Other aspects of maintenance (especially structural) are usually not done. As noted above, the users may do this work (either individually or as WUAs) under contract to the project or district office. Water users' groups may even be paid to carry out part of this small task.

The district or project office undertakes all other maintenance. Where there is a parallel donor-funded project (Hardinath), this is managed in conjunction with the on-going rehabilitation project. Elsewhere, this is dependent on HMG recurrent budgets. These are very variable and usually inadequate. Extra funds are available in some years for certain projects, usually as a result of political pressure. Thus Kankai and Jhaj have received greater funding this year. The quality is better in those projects where there are strong high-level WUAs to help in planning maintenance (which is in effect a form of joint management). This is so far only true of Kankai, and this is also better resourced. Despite this, the condition of infrastructure is deteriorating on all schemes. In most cases this is not so rapid as to cause loss of production in the short term and thus there is little pressure to improve standards. Emergency maintenance is thus often needed. Usually WUAs seek assistance from DOI for this, but they may undertake the work directly, as they have done when the main canal on the Bagmati project was breached.

(iii) Reliability of Water Distribution

Water distribution is mainly controlled by the performance of the main systems, for which the main decisions are taken by the DOI. However, the coordinating WUAs play a useful role in overall planning and communicating this plan to the users. Water users' groups assist in water allocation at a tertiary level, although there is no data on the reliability of that yet. The number of disputes is a proxy indicator for water distribution: on this basis Hardinath is the weakest. Although this has relatively strong WUAs, they do not have formal responsibilities for water distribution yet, and the overall availability of water is low.

Those projects in the southern part of the *tarai*, such as at Jhaj, have very low gradients and thus problems of drainage and flooding during the monsoon. Usually there is no way of controlling this. Such schemes are mainly for protective irrigation, to supplement monsoon rainfall. The benefits due to the irrigation system are relatively small, making it difficult to involve the farmers substantially.

None of the projects is able to measure flows delivered to WUAs, and thus there is no way of ensuring or monitoring equity of distribution. No schemes are designed with measurement structures at this

level. Farmers thus have little trust in the fairness of the distribution at main system level, which gives little incentive to improve management at tertiary level.

Table 4.6: Standards of Maintenance

Project	Component	Responsibility	Activity	Quality
Kankai	Main	DIO	DIO	Fair
	Secondary	WUA	WUA	Fair
Bagmati	Main	DOI		New project
	Tertiary	WUA		New project
Hardinath	Main	DIO	IMTP	Fair
	Tertiary	WUG	WUG	Fair
Jhaj	Main	DIO	DIO	Poor
	Tertiary	DIO (WUG)	DIO (users for emergency)	Poor
Tilawe	Main	DIO	DIO	Poor
	Tertiary	WUA - informal	WUA	Poor
Begnas	Main	DIO	DIO	Poor
	Tertiary	WUA - informal	WUA	Poor
Bijaypur	Main	DIO	DIO	Poor
	Tertiary	WUA - informal	WUA	Poor

(iv) Conflict Resolution

None of these systems has strong mechanisms for conflict resolution. The new WUAs have very limited powers to resolve disputes, and more commonly they refer to the VDC which now has the authority for this. In many cases, the disputes becomes politicised. This is a new role for VDC (dating back to the local governance act of 1999), and in the past the District or Project office was the first agency that disputes were referred to. The District Administration or DDC may be involved in cases of disputes between adjacent systems. Disputes are frequently referred to the courts. Major recent issues and solutions are summarised below.

Table 4.7: Conflicts on Agency-managed Irrigation

Project	Dispute	Role of:		Other Solution
		WUA	DOI	
Kankai				
Bagmati	No significant disputes			Local elite
Hardinath	With adjacent systems Water distribution in command	Outside responsibility Sometimes resolves	Outside responsibility Sometimes resolves	District Administration VDC if necessary
Jhaj	Water distribution in command Validity of WUA formation	Not yet active Cannot resolve	Usually resolves Cannot resolve	 Unresolved
Tilawe	Management responsibilities	Collapsed	Cannot resolve	Courts
Begnas	Water supply to new canal	Not yet active	Not involved	Municipality / elites for partial solution
	Water distribution in command	Not yet active	Not involved	Local politicians – substitute for traditional systems lapsed with land reform in 1960s
Bijaypur	In-field distribution	Not yet active	Not involved	VDC

4.3 Joint-managed Irrigation

This section is based on brief field studies in the following joint-managed irrigation schemes. These conclusions are also based on indirect data and discussions with users and other key stakeholders.

- Sunsari Morang Stage 1
- Sunsari Morang Stage 2
- Marchwar
- Khageri
- West Gandak

4.3.1 What is Joint Management ?

Joint management in Nepal is a system whereby users manage low levels of the system, and participate in certain activities at a higher level. It is a very useful concept as it puts the users in a position to influence management, without requiring them to undertake tasks beyond their capacity. The actual responsibilities vary, but are typically as summarised below.

Table 4.8: Responsibilities for Joint Management

Component	Decision	Finance	Implementation
Maintenance			
Field Channels	Users	Users	Users
Tertiary canals	WUG	WUG	WUG
Secondary canals	WUA and DOI	DOI (partly from ISF)	DOI, but may contract to WUA
Main canals	DOI with advice from WUA	DOI (partly from ISF)	DOI
Operation			
Field Channels	Users	Users	Users
Tertiary canals	WUG	WUG	WUG
Secondary canals	WUA and DOI	DOI	DOI
Main canals	WUA and DOI	DOI	DOI

The extent of users' involvement depends on the representativeness of the WUAs. This is relatively good at Khageri, which is a small project, but more problematic on the larger projects such as Sunsari Morang. As their financial contributions are extremely low, the WUAs are in a relatively weak position.

4.3.2 Status of Systems

There are few joint-managed systems in Nepal since the policy was only introduced in 1992 and it takes some time to achieve the process of transfer from agency- to joint-management. In addition to those studied here, Mahakali has been developed as a new joint-managed scheme. Some other schemes (Pathraiya and Manusmara) have recently been transferred to joint management.

The physical condition of these projects is relatively good as they have been built or rehabilitated under recent intensive programmes, and have not yet been transferred to District offices, with consequent reductions in funding.

SMIP is a very large project which has been in process of rehabilitation for 25 years. Stage 1 was complete in 1986, Stage 2 in 1995 and Stage 3 is still in progress. There have been some changes in approach over that time, but the infrastructure has been developed on a generally consistent basis. DOI manages the system as far as sub-secondary canal head regulators (typically 500 ha). Tertiary canals (around 100 ha) and watercourses (28 ha) should flow continuously when there is water in the sub-secondary, and there should be rotational irrigation below the watercourse level. This is a very logical and simple system which should result in equitable distribution without any further decision-making. However, performance does vary from the theory for a variety of institutional and physical reasons. The users were not involved in selecting this design: they do not all agree with it and thus make illicit adjustments to control structures.

Marchwar is new and in good condition; it was built to a high standard with external assistance and has needed relatively little work subsequently. The physical condition is still good, although it is slowly deteriorating as insufficient maintenance is done. Water supply in the river is ample, but needs to be pumped from the river into the main canal and the amount pumped is insufficient for the whole command. Water quality is also a concern since there is a brewery / distillery upstream which reduces crop yields and restricts use for livestock. The project was effectively entirely new, although there had been a surface system from much further upstream which had completely failed. There was a very

intensive programme of institutional development at the same time as physical development. Construction was completed in 1996, institutional support continued for two years when the system, excluding pump station, was handed over to WUAs. The pump station was handed over in 2000 and is now operated by the users although with large subsidies. An adjustable proportional system was provided. This is fairly sophisticated and was designed to be used in conjunction with a computerised water management model. Not surprisingly many slide gates have been damaged and they are very difficult to repair.

Khageri is an old system, built around 1960 and transferred to the farmers after some rehabilitation and an intensive institutional development programme in 1996-98. This has a limited water supply, and the infrastructure is in poor condition. This is one of the first AMIS to be transferred to joint-management with WUAs in Nepal and it remains one of the most successful. Nevertheless, there are problems in collecting user fees and in maintenance so the sustainability of the system is uncertain.

West Gandak is a larger and more problematic scheme, transferred entirely to the users under the same programme as Khageri. It has proved far less successful for a variety of reasons. A lack of any sound basis for collecting fees and for undertaking maintenance are among the reasons for this failure. The WUA has now become highly politicised and effectively non-functional. Infrastructure is poor, water supply is limited and controlled by India as the headworks is on the international boundary.

Table 4.9: Joint Managed Schemes Studied

Project	Area	Date	Control		Maintenance
			Main	Tertiary	
Sunsari Morang I	9,750	1986	Gated	Contin	DOI, exc watercourses
Sunsari Morang II	16,650	1995	Gated	Contin	DOI, exc watercourses
Khageri	2,850	1998	Gated	Contin.	WUA implements below main canal, plans main canal
West Gandak	10,300	1996	Gated	Gated	WUA, but unable to do in practice
Marchwar	2,950	1996	Gated	Module	WUA

4.3.3 Socio-economic Characteristics

The following tables provide some comparative social data on the projects. This is very approximate and is intended mainly to provide a context to review the different schemes. It was based on a rapid reconnaissance and some of this information is sensitive - farmers are often reluctant to reveal information on land ownership and there are many different possible arrangements. The classification by ethnic grouping is also simplified and contentious, but has been done to highlight some key differences between schemes.

Table 4.10: Ethnic Composition of Projects

Project	Tharu	Yadav	*Tarai* Brahmin	Hill	Other
Sunsari Morang	30	50	5	5	10
Khageri		1	1	98	
West Gandak	25	10	5	20	40
Marchwar		25	15		60

Table 4.11: Educational Status

Project	% Adults who have attended school	
	Male	Female
Sunsari Morang	55	30
Khageri	na	na
West Gandak	na	na
Marchwar	50	20

Table 4.12: Land Tenure (among Water Users)

Project	Landlord (non-cultivator)	Owner cultivator	Landless cultivator
Sunsari Morang	8	85	7
Khageri		100	
West Gandak	na	na	na
Marchwar	5	85	10

Table 4.13: Cropping and Irrigation Intensity

Project	Annual Crop %	Irrigation %	
		Annual	Spring
Sunsari Morang	190	150	20
Khageri	210	145	15
West Gandak	180	145	0
Marchwar	200	150	0

4.3.4 Governance of WUA

(i) Basis for Formation of WUA

The WUAs were all set up by DOI, following awareness-building campaigns, to meet the requirements of the irrigation policy. Older WUAs (such as SMIP) were set up and registered in accordance with the Associations and Organisations Registration Act (1977), but the more recent schemes have used the simplified procedures given in the Irrigation Regulations (1999). There was some understanding of the irrigation policy, the legal requirements for associations, and the reasons and the implications of this policy, but there is still little evidence of either demand to take over management responsibilities or recognition by the users that WUAs are intended for this purpose.

These are all old projects that were originally set up without user-participation. In some cases there were small indigenous schemes beforehand, but these were ignored in the design of the new systems. Thus there was no indigenous organisation to build on when later planning participatory management. By then users had come to expect that DOI would manage all aspects of the project, and it has proved difficult to change this perception. Khageri and Marchwar WUAs were set up in advance of rehabilitation and were given very intensive support, which was possible because of the small scale of the projects. SMIP and West Gandak have been more difficult to transfer, as they are inherently more difficult to manage with more serious problems of water shortage and sedimentation, and have been more intensively managed by DOI in the past. There was less user involvement in design of rehabilitation of SMIP, and very little was done on West Gandak, so farmers have less interest in managing these projects.

The immediate motivation for forming the groups has usually been to improve participation in rehabilitation and hence the efficiency of this investment. As Khageri and Marchwar were pilot programmes for irrigation management transfer, the WUAs were given intensive training to develop their longer term management role. SMIP is slightly different in that the WUAs were only set up after the rehabilitation was complete, and thus it is not surprising that these are not so strong. The WUAs still rely heavily on DOI for most activities as rehabilitation is still ongoing in other parts of the same project.

(ii) Definition of Functions of WUA and Clarity of Roles

Formal joint management agreements have been set up on all these projects, which set out the various responsibilities, but there are still some problems with defining functions. SMIP has been designed as a structured system with the last gated control at the head of sub-secondary canals (500 ha). At lower levels, the canals should flow continuously but individual outlets to 4 ha blocks should be rotated. The lowest level of user group is thus the WUG responsible for 28 ha (7 outlets) and should manage this rotation system as well as watercourse maintenance.

In practice, however, watercourses do not run continuously and there is an informal sharing system between watercourses from a tertiary canal. However, there is no user group at this level. The next level in the hierarchy is the water user committee, responsible for the whole sub-secondary canal. However, this is maintained by DOI and has no adjustable control structures. This leaves the WUC with a very small role, largely as an intermediary. It should also collect fees, but as it is not a registered legal entity it has little authority to do this, and it deposits funds in the bank account of the Water Users' Coordinating Committee (WUCC). This is the only level that is able to manage finances. This is really responsible for coordinating management of the secondary canal (5,000 ha). Thus there is an elaborate hierarchy of WUAs, with a large number of people involved, but very limited functions. In practice it is usually one individual with the committee that undertakes the work.

Marchwar has more demanding requirements as the whole 2,800 ha project is the responsibility of the WUA, and the supply is pumped from the river. They collect fees from the users and pay WUA officials and pump operators. DOI pays the majority of maintenance and pumping costs. The WUA also raise money by sale of timber from trees on canal banks (this is managed by a forest users' group, but the same people are members of this groups). The project was handed over to the WUA two years ago, but they now feel that it should be jointly managed since the policy recommends joint management for projects over 2,000 ha. DOI is still responsible for major repairs, for which there are defined categories, and emergencies. The WUA cleans the canals, to some extent, and keeps the pumps operational – which is a significant achievement. As the civil works are new, little other maintenance is needed. Most of the DOI maintenance expenditure has been on improvement works including canal lining.

In SMIP, the division of responsibilities is relatively well-defined. However, DOI is responsible for some task – such as maintenance of tertiary and sub-secondary canals – which more logically would be WUA responsibility. It also pays the salary of one member of the WUA to collect fees. It thus takes on a much larger role than it should, which leaves the WUA with a very limited function. There is some confusion between tiers of WUA, since only one level is registered and thus legally able to manage finances. However, this acts more as a coordination committee whereas most physical activities are done by lower level WUAs, which do not have access to these resources. The system is designed so that the users have no control or influence over how much water they receive, and they should allocate this on a strict rotation without any further decision-making. They were not involved in selecting this design and do not agree with this and thus make illicit adjustments to control structures.

The WUA committee members may also manage maintenance of the main canals (eg the main canal at Khageri and the sub-secondary and tertiary canals at SMIP) under contract to the project office and employ the users on this. This is a legitimate way of involving the users in the joint-managed parts of the system, provided it is done in a transparent manner – it can sometimes cause mistrust between the committee and general membership. This can then affect their ability to manage the lower levels of the system.

(iii) Appropriateness of Organisation and Awareness of Responsibilities

Organisational arrangements for all these WUAs are also standard and similar to those described earlier for AMIS. There were some small FMIS within the command areas before these schemes were built; these were ignored in the construction of the new systems and the traditional management lapsed also. Some farmers in SMIP complain that they get less water than they used to, but this cannot be substantiated and in any case upstream development would almost certainly have undermined these traditional schemes by now.

As is so often the case, these WUAs interpret their main responsibility as being to assist in rehabilitation and construction management, and seek additional resources to maximise the amount of work that is done. Once this stage is complete, they either lapse or seek to attract further external resources, from sources such as DOI as well as VDC and MPs grant allocations.

The more intensive institutional support programme for Marchwar has resulted in a much greater awareness of responsibilities, but not necessarily in ability or willingness to discharge them. They feel that it is difficult to enforce rules at a time of political unrest, and in some cases they do not want to as they fear this would influence their chances of re-election.

(iv) Data and Management Systems

These WUAs all have separate offices that were provided by the project. However, they suffer – to varying extents - from inadequate management systems. At West Gandak there does not appear to be

any list of members which can be used as a basis for collecting fees. Although there are such lists at SMIP it is difficult to keep them up-to-date as land changes hands. The fees are set at an arbitrary level, unrelated to management requirements. Part of this returned to the users for maintenance of their canals (watercourses in the case of SMIP) but the fee level is so low that this is inadequate even for that. It is quite inadequate for management of the main system and probably costs more to collect than is collected.

Most WUAs keep a minute book in which they record attendance and decisions taken at meetings, but few other records are kept. There have been no meetings on SMIP stage 1, where construction was finished some time ago, for two years, whereas they still continue on parts of SMIP where there is still some involvement by the DOI. Most meetings are instigated by project staff, and most issues discussed relate to requests for construction. There are few decisions taken which are actually implemented by the WUA.

Marchwar appears to have one of the best management systems, with well-defined procedures and a well-equipped office. This is essential, since it needs to employ several people for operation. It may be over-bureaucratic and it needs to streamline operations so that salary costs can be reduced.

(v) Financial Management and Transparency

These WUAs do have some finances to manage and at least one tier of WUA keeps a bank account. Their finances are much more limited than they should be since they are unable to enforce collection of ISF. Marchwar achieved about 70 % collection in 1999, which was insufficient for salary costs. The fee was increased from Rs 180 to Rs 300 per hectare in 2000, but they still need to achieve a collection efficiency of 70% on the actual irrigated area (1,400 ha) just to cover staff costs (at current staffing levels). They achieved a good collection in 2000 since only those who paid ISF were eligible to vote in the WUA elections. As this is a turnover scheme the entire fee is retained by the WUA and they do not pay any to DOI. They are able to collect some other fees, for example timber from trees grown on canal banks and fish in the canals. The amount collected from these can be almost as high as the direct user charges, but there is a risk of asset stripping as can be seen in the case of the main canal trees on West Gandak.

The situation in SMIP is less satisfactory. The ISF has been increased to Rs 200 per hectare, which has to be shared out between a large number of different committees. Collection was good when it was linked to payment of land tax, since it was not possible to pay land tax without presenting a receipt for ISF. This system has been abolished, although many farmers would like it reintroduced, and the fee is now collected by project staff. The amount collected is so small that it has little impact on O&M, since maintenance costs alone have been estimated to be around Rs 500 per ha.

There are systems for collecting contributions to maintenance (as cash or labour) on these schemes. These contributions are usually based on area cultivated (typically Rs 60 per hectare). A small contract is usually awarded to local people to carry out the work. The contract is for the total amount collected so there is little problem of accounting for the money. Simple payment systems, such as Rs 4 per metre for watercourse cleaning, are used so that the expenditure can easily be verified. In situations where labour (rather than cash) contributions are expected, this is fixed as a certain number of days per household (regardless of farm size) – this is less fair but easier to manage.

(vi) Autonomy

As in the case of AMIS, these WUAs are rarely autonomous, and many people do not see this as important. Influential people are often purposively selected so that they can influence DOI and local government. One of their major roles is to act as means of communication between the DOI and the users, and they may be selected with this in mind. WUA committee members are almost invariably

associated with political parties and this influences they way they operate. In Marchwar, they are reluctant to enforce rules if they feel this would influence their chances of re-election. Elections are relatively frequent at Marchwar and these positions confer a certain status on the holders which gives them an importance outside their immediate function. They are also dependent on DOI for the majority of their financial resources, but to their credit they collect sufficient in direct user fees to cover most operation costs.

4.3.5 Performance of Systems

(i) Introduction

This section reviews the overall performance of the schemes in qualitative terms and distinguishes between the performance of the WUA and the agency responsible for main system management. Formal data on these issues will be collected by direct observation on selected schemes in stage 2.

(ii) Quality of Maintenance

These are all newly rehabilitated schemes so the physical condition is mostly good. West Gandak is the exception to this as the extent of rehabilitation was very limited and some significant problems were not tackled. The very high sediment load has made this already difficult problem too great for the WUA to resolve. The main maintenance responsibilities of these WUAs are to manage unskilled labour for canal cleaning. This is a very simple task for low-level canals, and requires little coordination of users. It becomes increasingly difficult at higher levels in the system. Standards of maintenance of the main canals at Marchwar, where the WUA is responsible for the entire system, are not very good but the tertiary canals and below are in satisfactory condition. In the other schemes, the users are only responsible for low level canals (secondary at Khageri and watercourses at SMIP) and thus there are relatively few problems with this.

Other aspects of maintenance (especially structural) are less likely to be done. Where the maintenance is the responsibility of the project or district office, the users may do this work (either individually or as WUAs) under contract. The quality is better in those projects, such as Khageri, where there are strong high-level WUAs to help in planning maintenance. In most cases, the infrastructure is still in good enough condition that there is little risk of loss of production in the short-term and thus there is little pressure to improve standards.

(iii) Reliability of water distribution

Water distribution is mainly controlled by the performance of the main systems, for which the main decisions are taken by the DOI. However, the coordinating WUAs are influential in ensuring that the needs of the users are incorporated in planning and then in communicating the plan to the users. They are weakest in this role on West Gandak, since this is on a boundary river and the headworks are controlled by India.

These schemes are more intensively managed than most AMIS as they are pilot projects which have received much greater investment than other schemes, and over a longer period. Although the Narayani project was developed in a comparable manner to SMIP, this support was not continued for so long. It remains to be seen whether the better performance on SMIP can be sustained after the support is reduced.

Water users' groups assist in water allocation at a tertiary level, although there is no data on the reliability of that yet. The number of disputes is a proxy indicator for water distribution: on this basis West Gandak is the weakest. Those projects in the southern part of the *tarai*, such as at Marchwar,

have very low gradients and thus problems of drainage and flooding during the monsoon. Usually there is no way of controlling this.

Table 4.14: Maintenance of Joint-managed Irrigation Systems

Project	Component	Responsibility	Activity	Quality
SMIP	Main	Project	Project	Fair
	Tertiary (100ha)	Project	Project	Poor
	Watercourse (28ha)	WUG	WUG	Poor
Khageri	Main	Project / WUA	Project / WUA	Fair
	Secondary	Branch WUA	Branch WUA	Fair
	Tertiary	Users	Users	Good
West Gandak	Main / Secondary	WUA	IMTP	Poor
	Tertiary	WUA	WUG	Fair
Marchwar	Main	WUA	WUA	Poor
	Tertiary	WUA	WUA	Fair

These projects have all been developed on the assumption that WUAs will be able ensure (and monitor) an acceptable distribution of water, using informal controls. However, they were not involved in planning what this distribution should be and the actual distribution of water appears to be quite different from the theoretical; farmers thus have little trust in its fairness. Supplies from the main system to the WUA-managed blocks are allocated proportionately (according to net command area) on SMIP and Marchwar - they are not controlled separately. The system at Khageri and West Gandak (which are older) is more informal, with approximate control and neither measurement nor proportional control. The relatively successful performance at Khageri suggests that this is acceptable on small projects (Abernethy, 2001), but it may be difficult to adopt this approach on larger schemes. The structured design adopted on SMIP is designed to make operation as simple as possible, but it has not yet had the desired impact – possibly because it is too sensitive to fluctuation in water supply, or because the users do not fully understand or agree with the concept.

(iv) Conflict Resolution

None of these systems have strong mechanisms for conflict resolution. The new WUAs have very limited powers to resolve disputes, and more commonly they refer to the DIO or project office. The VDC now has the authority for this, but this is a new role for them and they are not yet widely involved. Major recent issues and solutions are summarised below.

Table 4.15: Conflicts on Joint Managed Irrigation

Project	Dispute	Role of:		Other Solution
		WUA	DOI	
SMIP	Collection of fees; canal road taxes; and land for field channels	Not involved	Could not resolve	Court
Khageri	No significant disputes, some lingering from rehabilitation Water availability declining due to upstream development		New project proposed	
West Gandak	Activities of WUA – accusations of corruption	Cannot resolve		Status of project under review
Marchwar	Water distribution in command Pollution by upstream users	Solves minor disputes Cannot resolve	Resolves large disputes Cannot resolve	 Unresolved

4.4 Farmer-managed Irrigation

4.4.1 Introduction

This section is based on brief field studies in eight farmer-managed irrigation schemes, supplemented by indirect data and discussions with users and other key stakeholders. Information from some other schemes has also been included as appropriate. It should be noted that these are large FMIS, and in some cases have been enlarged further by the Government. They are not necessarily typical of the smaller schemes that are more common throughout the country.

They are all old well-established schemes and all have been intervened by the Government, in some cases more than once. They were originally developed and managed by small numbers of landlords (*jamindar*), but have subsequently been enlarged and changed to more communal management. This sometimes involved combining several small schemes into one. In some cases (Tika Bhairab and Mahadev *khola*), the Government took over management after rehabilitating the schemes in the 1970s but these soon reverted to local management.

In all of these cases the actual areas were found to be substantially less than that reported in official statistics – it appears that areas are inflated in order to justify the rehabilitation. This has several implications:

- The rehabilitation was not designed for the actual area.

- Many beneficiaries gain little from the project although they may have been obliged to contribute.
- The true project boundaries are ill-defined.
- There is no accurate database of members.
- There is an inadequate resource base for O&M.

4.4.2 Physical Status

Rehabilitation generally focused on the headworks and a small number of other structures – especially cross-drainage and road crossings. Much less work was done on the distribution system, and this remains essentially traditional. This concentration of resources caused some dissatisfaction if the remaining infrastructure was inadequate to get water to the whole command area, despite expenditure of up to $1,000 per hectare. In most cases the headworks have performed well, but where water levels have been raised to increase command areas there have been downstream impacts. Higher canals impede drainage and combined with inadequate provision of cross-drainage structures this can cause serious maintenance problems (as for example at Bighi). At Siyari, the structure was designed for a single offtaking canal, but the farmers subsequently built a second canal. This caused the structure to be bypassed and now it cannot be used as designed.

The benefit of new headworks is to reduce the amount of maintenance in constructing temporary weirs each year, and increasing water availability in cases where that maintenance would have been inadequately done. In some places, this is required to enable the users to continue operating systems in changed social circumstances which make mobilising large numbers of labourers much more difficult than in the past. In some places (eg Pithuwa in Chitwan), bulldozers are made available for this purpose and the rehabilitation has given greater emphasis to the distribution system. However, the cost of having construction plant on standby during the monsoon makes this a difficult approach to replicate.

Table 4.16: Projects Studied

Project	Area (ha)	Nos VDCs	Date of last intervention
Sundari	700	4	1995
Bighi	1,000	5	1998
Aruwa	800	3	1998
Imriti	700	3	1994
Siyari	400	1	1980
Tika Bhairab	450	5	1990
Mahadev *khola*	250	1	1997
Rajapur	12,000	11	2000

4.4.3 Socio-economic characteristics

The following tables provide some comparative social data on the projects. This is very approximate and is intended mainly to provide a context to review the different schemes. It was based on a rapid reconnaissance and some of this information is sensitive - farmers are often reluctant to reveal information on land ownership and there are many different possible arrangements. The classification

by ethnic grouping is also simplified and contentious, but has been done to highlight some key differences between schemes.

Table 4.17: Ethnic Composition of Projects

Project	Tharu	Yadav	*Tarai* Brahmin	Hill	Other
Sundari	30	20	30		20
Bighi		35	55		10
Aruwa		50			50
Imriti	15	15	10		60
Siyari	40	20		10	30
Mahadev				100	
Tika Bhairab				100	
Rajapur	56			38	6

Table 4.18: Educational Status

Project	% Adults who have attended school	
	Male	Female
Sundari	50	40
Bighi	20	10
Aruwa	40	20
Imriti	10	1
Siyari	30	20
Mahadev	60	35
Tika Bhairab	30	10

Table 4.19: Land tenure (among water users)

	Landlord (non-cultivator)	Owner cultivator	Landless cultivator
Sundari	1	90	9
Bighi	10	80	10
Aruwa	5	80	15
Imriti	5	95	0
Siyari	0	98	2
Mahadev	3	92	5
Tika Bhairab	10	85	5

Table 4.20: Cropping and Irrigation Intensity

Project	**Annual Crop %**	**Irrigation %**	
		Annual	**Spring**
Sundari	210	150	20
Bighi	150	115	5
Aruwa	140	130	0
Imriti	195	145	0
Siyari	190	160	0
Mahadev	200	195	0
Tika Bhairab	205	200	0

4.4.4 Governance of WUA

(i) Basis for Formation of WUA

These are all old schemes, on which WUAs have been set up recently by DOI to meet the requirements of the irrigation policy and make them legal entities that can manage finances. They all had well-established traditional management arrangements which were effective but informal. These had to be formalised as WUAs to enable them to participate in Government programmes. Their motivation was thus construction rather than management. It was rarely possible to register the traditional organisation for this purpose, either because traditional managers were sometimes regarded as labour 'contractors' without either the education or status to take on the new role, or because scheme boundaries were extended or separate schemes combined during rehabilitation.

WUA chairmen were often selected for their ability to manage construction; they may even have been the contractor for rehabilitation. This may mean that the users' contribution (15 % of total cost) can be covered by the contractor. This is reportedly common (eg at Sundari) but obviously not documented. These new WUAs thus serve a short-term role and may leave routine management to the indigenous organisation.

The WUAs are more required to be democratic than traditional management, which in most of these cases was derived from the *jamindari* system where tenants were required to maintain the canal system and the *jamindars* (landlords) controlled the allocation of water. However, in practice they follow the traditional system, and the hierarchy of democratically elected WUAs usually have little power.

(ii) Definition of Functions of WUAs

The theoretical functions of the WUA are easily defined. There are few complex tasks and the village has been managing the system in the past.

- Maintain headworks, canals and any other structures.
- Employ gate operators, watchmen etc as required to operate the system.
- Collection of labour and other resources for management, for canal cleaning, payment of operators, and purchase of other supplies.
- Provide water in appropriate time and quantity to users.
- Resolve conflicts, or where not possible refer to the VDC for solution.

In practice there is some confusion over who in fact should undertake these tasks, as described below.

(iii) Clarity of Roles

These schemes are entirely farmer-managed and thus the role of the WUA should be unambiguous. However, as the schemes are relatively large, there are some problematic issues:

- How responsibilities are assigned to different levels of WUAs.
- How traditional arrangements are integrated into WUAs.
- How the WUAs interface with other organisations, such as VDCs (esp multiple VDCs).
- Coordination between separate systems on a single river.
- Under what circumstances should the DIO become involved.

In some cases the VDCs are explicitly involved (at Mahadev *khola*, the users deliberately elect VDC chairman to lead the WUA to ensure that they have access to VDC resources), in others such as Bighi they are involved informally because the same individuals are members of both committees and in yet others the WUA and VDC are completely separate.

At Imriti, the WUA members come from different parties to the VDC, which therefore has other priorities for use of its funds. The relationship between WUA and VDC is easiest in cases such as Mahadev *khola* where the project serves almost all of a single VDC, but this is unusual. At Aruwa, the scheme was originally built by an ancestor of one of the three current VDC chairmen, and he devotes VDC resources to the scheme. Often funds required for construction are provided directly by the VDC rather than directly by the users.

It is common for traditional management to be linked informally into the WUA. The WUA was set up mainly for construction management so it delegates routine management to the traditional system. This however, means that is no need for the WUA to continue to exist once construction is complete since there is little change to the management requirements in the short term. It also implies that the institutional development effort is targeted at what is essentially a transient organisation, whilst the real managers are not given any direct assistance. Traditional management was usually a much flatter structure, with each village managing all of their infrastructure and just a single person coordinating between these.

Coordination between successive FMIS on a single river is traditionally managed by ensuring a minimum distance between schemes. The leakiness of earth/brushwood weirs ensured a reasonable distribution of water, and any residual conflicts were solved by the district administration. Permanent, impermeable structures change this situation and there is thus considerable potential conflict, although that was not observed on these schemes. As these schemes cover more than one VDC, resolution of such problems would now be the responsibility of the DDC.

(iv) Data and Management Systems

Although the Irrigation Regulations require the WUA to maintain records and to submit an annual report, this is never done on the schemes visited. There was no need for formal data management in the past, and they continue to work on the same basis. Formal meetings of the WUA are rarely held, except when the AO from DOI visits. None of these WUAs actually collects any fees from the users. The changes in boundaries following rehabilitation mean that they do not have an accurate list of beneficiaries.

(v) Financial Management and Transparency

Traditional management relied on labour contributions as needed. If valued at standard market prices, these may be equivalent to up to Rs 1,000 per hectare; this is much higher than the ISF levied on modern irrigation but it does not mean that farmers would be willing to pay this amount in cash even irrigation was reliable. Sometimes grain is provided to compensate a gate keeper or *chaukidar* but it was rare for cash fees to be collected. This has not changed in practice although modern structures will require some cash expenditure. VDCs have some funds now (with central government grants provided since 1994, plus some local revenue sources). These are often but not always made available to irrigation systems. At Sundari, the WUA vice-chairman is VDC chairman and thus there is a close link, but at Imriti the WUA and VDC representatives are rivals, from different parties.

They have attempted to collect WUA membership fees or water charges on some schemes, but none have succeeded. The users feel that these schemes should be managed in the traditional way (through labour contributions or payments in kind) and that there is no need for cash. They have little trust in the way any cash would be managed. In some cases they use VDC funds but these are managed directly by the VDC rather than the WUA.

On most schemes at least one tier of WUA keeps a bank account. In some cases, they are jointly managed with the District office – this is required at the time of rehabilitation and sometimes continues after the project is complete. As they are unable to collect cash the money in these accounts is usually just the residue from the contributions for construction.

(vi) Autonomy

WUAs on FMIS are more often closely linked with the VDC, particularly if the project covers most of a VDC. These WUAs are likely to get fewer resources or support than AMIS from DOI and thus they rely to a greater extent on the VDC who often contribute cash from their own resources for maintenance. This is not a formal or consistent system and depends more on the personal relations and political party affiliations between key individuals in the two organisations.

Irrigation, however, usually only benefits part of the community and thus the VDC may give it a low priority. For example, at Imriti they are devoting their resources to school construction, roads and electrification which all have a wider impact. At Mahadev *khola*, the VDC is expected to take a leading role, and the WUA automatically select the VDC chairman as WUA chairman. Where a WUA covers more than one VDC, usually one VDC takes a leading role – this is typically the one closest to

the intake (or who were most involved in the original construction) who are in the best position to undertake emergency maintenance. In other cases, such as Bighi, a tail-end VDC is assigned this role as they have the greatest interest in the scheme being well-managed.

4.4.5 Performance of Systems

(i) Quality of Maintenance

The WUAs manage unskilled labour for canal cleaning. In some cases they will get assistance from other projects or VDCs. Users say that obtaining external assistance is an important part of the WUAs role and it helps improve standards of maintenance. If the rehabilitation was done well there are few problems of maintenance. The major gated structures are the main potential problem, and in no case was there any sign that WUAs did more than grease gates. In those cases, such as Bighi, where the rehabilitation was more ambitious there are more serious problems of maintenance due to lack of cross-drainage. Although these are within the capability of the WUA, they are unwilling to attempt a permanent solution as they feel this should be DOI's responsibility.

Most schemes rely on contributions of unpaid labour for maintenance; these are normally based on a certain number of days per houshold (rather than per unit area).

(ii) Reliability of Water Distribution

All schemes rely on simple methods of sharing water. Where water is short, a time-based system is adopted. At Sundari and Aruwa the schedule had to be arbitrated externally, but elsewhere the users make their own arrangements. These are informal since water is often sufficiently abundant and it is not worth the difficulty in setting up strict systems. These schemes are mainly used for protective irrigation on field crops.

(iii) Conflict Resolution

Conflicts have been reported on most of the schemes in the past. In some cases these have been referred to the District Administration or courts, but there are no serious on-going disputes on these schemes at present. The new WUAs have limited powers to resolve disputes, and more commonly they refer to the VDC which now has the authority for this. In some cases, the disputes then become politicised. Major recent issues and solutions are summarised below.

Table 4.21: Conflicts on FMIS

Project	Dispute	Role of WUA	Other Actors
Sundari	Water distribution	Vice chairman resolves, ratified by WUA	Major allocation decided by CDO
Aruwa	Participation in maintenance	Resolved by WUA	
	Water distribution between systems	Informal arrangements	
Imriti	Water sharing		*mukhiya* / VDC
Siyari	Water distribution		*aguwa*
Tika Bhairab	Water distribution	Can solve	
Mahadev *khola*	With upstream system		VDC attempt to solve, but no final agreement
Rajapur	Between branch canals	None	VDC, district administration, courts

4.5 Irrigation and Sustainable Livelihoods

A sustainable livelihood can be defined as one that can cope with shocks and maintain its capabilities and assets without undermining the natural resource base (Carney, 1998). Individuals and communities have a number of different assets or resources that they can draw on. Irrigation can influence these in several different ways, and development of sustainable local institutions to manage irrigation can benefit both individuals and communities in a number of ways as summarised below (after Pokharel, 1999).

Table 4.22: Irrigation and Sustainable Livelihoods

	WUA	Household
Social capital	Enhanced capacity for collective action, local democratic development, and conflict resolution	Enhanced ability to influence community, improve social standing, assert rights
Human Capital	Improved skills for water management, organisation, communication	Skills in agriculture, water management, participation, financial management
Natural Capital	Equitable use of water resources	Awareness of protection and regulation of water resources
Financial Capital	Establishment of local funds for O&M	Awareness of need to contribute in order to benefit from irrigation
Physical Capital	Maintenance of infrastructure and ability to attract additional investment in infrastructure	Skills in construction and maintenance

These are theoretical impacts and the extent to which they can be achieved depends on the local situations.

(i) Social Capital

There is anecdotal evidence that irrigation is better managed by certain ethnic groups, and by socially homogeneous communities (single ethnic groups, with few large landlords). The *Tharu* in the *tarai* and *Magar* in the hills are particularly noted for their skills in irrigation management, and more specifically in the ability to manage community labour for maintenance of irrigation canals as well as other communal infrastructure, such as roads. Evidence of this can be seen in the watercourses in SMIP which are dominated by *Tharu* farmers, and in the indigenous schemes such as Rajapur. Rajapur also indicates that such organisations, once established, can be sufficiently robust to withstand considerable immigration to the area, since almost half the population are now non-*Tharu.*

However, this is just one characteristic of successful community management, and there are many exceptions to this pattern. Other significant issues may include land holding size and security of tenure. Traditional irrigation in the *tarai* was often based on the *jamindari* (landlord) system, with enforced participation by the actual cultivators. This has been abolished, but experience at Bighi suggests that this makes irrigation more difficult, with even small farmer-managed irrigation systems collapsing. Landholdings have been broken down because of land reform legislation, and sharecropping and tenancy is concealed. This makes it difficult to ensure effective participation by true stakeholders, who also have a declining interest in irrigated agriculture because of the low profit margins and better opportunities in India and the Middle East.

Farmer-managed irrigation is often broken down into physically discrete units to reduce the need for cooperation on a larger scale. Modern irrigation has particularly high demands since cooperation is required between groups of farmers formed to suit hydraulic, rather social, units. Many of these farmers may be migrants to the area.

There is little evidence of good irrigation management encouraging local democratic development since it tends to reflect rather than influence other local organisations or power structures. This may just reflect the weakness of WUAs at present, but it is notable that many villages prefer to use VDCs – the democratically elected body – for irrigation management. WUAs are rarely elected democratically and many people criticise them for that (notably at Kankai). Detailed studies would probably uncover some more subtle effects; there is greater evidence of the benefits of wider participation in decision-making for construction than there is for management). There are two basic options:

- giving an effective irrigation management role to VDCs with a small higher level WUA to coordinate between VDCs; or
- democratising WUAs, which in the past has proved to be very difficult.

This is an emerging issue in Nepal, which is attracting much debate in water and other sectors although it is unlikely to be resolved in the short term because of the uncertain future status of VDCs. These have been dissolved but no date has been set for new elections and the interim arrangements are unclear and disputed.

Conflict management systems are relatively weak on many irrigation systems. Efficient WUAs or informal organisations can reduce the need to guard irrigation supplies, particularly at night – this can be seen on selected watercourses at SMIP as well as on well-managed FMIS such as Imriti. This is a particular benefit for women-headed households. More serious disputes are often referred to courts and other external agencies (for example during the establishment of Imriti). There are many different potential places to resolve such conflicts so it is often difficult to reach a ‘final’ solution (Khadga, 2000).

Gender roles in irrigation institutions are of particular interest. Women play a crucial role in agriculture, and this is increasing with growing short-term migration of men for off-farm employment. Women are traditionally excluded from some tasks specifically related to irrigation – including canal maintenance – as they are considered polluting. However, this situation is variable and is also changing. Attempts to increase women's involvement by positive discrimination in WUAs has had little impact, and women more often exert their influence informally outside the WUAs or simply assert their independence from it (as in the case at Chattis Mauja noted by Zwarteveen & Neupane, 1996). This excludes their voice from activities where the WUA is effective - perhaps most significantly in planning rehabilitation - but the impact on management is less clear.

(ii) Human Capital

A wide range of skills are needed for irrigation management, both for management of the system as a whole (including general and financial management, as well as technical skills) and for irrigated agriculture. Skills in participation and community development are also useful in a wider range of activities. These skills are relatively weak, and have been given little attention in irrigation programmes. Some training, focusing mainly on WUA office holders has been given but there has been insufficient follow-up.

(iii) Natural Capital

The key issue is availability of water. This availability as well as quality for an individual scheme may change due to changing land use elsewhere in the catchment – due to industrial or urban development as much as increased irrigation. Water quality is still generally good but Bighi, Tika Bhairab and Marchwar all reported problems with industrial pollution (which they are unable to address, so this is an emerging issue which needs to be tackled seriously). Traditional systems for allocation between irrigation schemes or canals are relatively well defined. Conflicts arise more as a result of changing uses – new legislation gives priority to drinking water and there is no established mechanism for transfer of rights. Modern irrigation relies on much more intensive use of water than traditional systems, creating difficulties when systems are extended or when trying to introduce concepts from indigenous systems.

Irrigation has often been developed around available water sources, with less consideration of other natural issues such as land suitability for irrigation. A number of schemes, such as Hardinath and Jhaj, show a relatively small benefit, because of soil types, and this clearly affects the willingness of farmers to invest in developing management organisations.

(iv) Financial Capital

Indigenous irrigation relies on labour for maintenance, possibly with payments in kind for supervisory staff. This is under threat, even on traditional irrigation, as people become less willing to participate and as irrigation becomes more dependent on cash for materials or skills. There is little precedent for collecting significant amounts of cash, or for building up maintenance funds. A succession of national irrigation sector projects has provided considerable resources for deferred maintenance, improvement or enlargement of these schemes. This is a disincentive to the farmers.

Agency-managed irrigation is traditionally subsidised by the state, and there has been little progress in sustained collection of service fees. However users do collect maintenance fees on SMIP and other new projects which they invest immediately in maintenance for small channels. They do not have any systems for keeping funds, and few users would trust WUAs with this task. This would require improvements in social and human capital to build networks and manage disputes.

Internal resources are severely constrained by agricultural output prices which have been declining for some time, making it difficult for smallholders to make a good income. Indian agriculture is more heavily subsidised and it is difficult for Nepali farmers to compete particularly since inputs are difficult to obtain and of unreliable quality. Off-farm employment, where it exists, is more profitable. However, there are some profitable cash crops, notably vegetables although the markets are limited. The benefits of irrigation may thus be relatively low in some areas, making the return to investment in improved management rather small.

Alternative sources are sometimes available, since VDCs now have some resources with an annual allocation from central government of NRs 500,000 (about £5,000) and discretion on how this is spent. There are many demands on these funds, and it is not always available for irrigation management. Other Government agencies have some funds and in some areas NGOs are also involved. Water users may generate other local sources of income, such as from sale of timber grown on canal banks or fish in ponds or canals; rental of land for shops; and tolls on canal roads.

(v) Physical Capital

The dominance of engineers in irrigation development in Nepal ensures that technical matters receive considerable attention. However, the relationship between technical and organisational aspects is often understated. The physical layout and institutional structure of indigenous irrigation developed together, whereas on modern irrigation they have often been regarded as parallel but separate activities. Most modern irrigation was developed before participation became a formal requirement and thus users have only been involved substantially in rehabilitation when there are fewer options for ensuring the design suits their needs. There are also various different styles, according to the age of the project and preferences of the designers.

Changing the type of management on an established system is thus particularly difficult. Issues include:

- Type of control structures (main system and tertiary level).
- Layout of canals.
- Size and complexity of whole project and scope for sub-division into local management units.

(vi) Political Capital

Baumann (2000) has suggested that a sixth form of asset – political capital - should be introduced to the framework. Formation of groups does need to be examined in the local political context – forest users' groups can exclude previous users from common land. Baumann argues that "local government creates the framework that allows social capital to grow, rather than the other way round … local people need political capital in order to claim rights and defend them. These … suggest that participatory development cannot be considered without reference to the political framework in which associational life operates." WUAs appear to be important in helping local leaders develop their local power base and thus have a much larger significance in practice than there official role for irrigation management. Indeed that may well be secondary, and this ahs major implications for developing effective groups.

4.6 Comparison with Forest Users' Groups

In view of the widely perceived better performance of Forest Users' Groups, an initial comparison has been made of WUGs and FUGs. Under the DFID funded NUKCFP, 1880 FUGs were established in 7 districts. These covered an area of 120,000 ha (64 ha/group) and benefit around 180,000 households

(100 hh/group). In scale these are comparable to water users' groups for tertiary canals on AMIS or for small FMIS. There are no higher level associations, such as are required for managing larger parts of irrigation schemes, but district associations of FUGs do cover some of this role – particularly for conflict management. There resources are still limited (averaging Rs 7,000 per group), and only 16% were classified as active in 1999 although one third have developed some income generating activities (ref. NUKCFP annual report, 2000).

This is a significantly better performance than for irrigation organisations. The WUAs studied in phase 1 were mostly for larger units, which made them more complex, but none had raised any funds for management although some had mobilised labour contributions. Traditional management arrangements were active on some FMIS (eg Imriti), and WUAs on two joint-managed schemes (Marchwar and Khageri) were partially active – these had both had prolonged support programmes. All others were essentially non-functional.

A number of differences can be identified. For example:

- Membership is defined by the forest users' group, and is not pre-determined by the irrigation system layout as in the case of water users' groups.
- Areas to be managed and numbers of people to cooperate tend to be larger for irrigation.
- Resource requirements for forestry management are small in comparison to irrigation management.
- Capital invested is much less than in irrigation infrastructure.
- Forest management yields communal products of direct value to users, whereas water is an intermediate product which enables individuals to produce private goods.
- Forest management is less time-sensitive than water management.
- Forest resources are common properties that increase and can be seen to increase in value annually.
- Maintenance requirements of forests are not as critical as water systems.
- Lowland tenurial patterns are more complex and consequently it is more difficult to organise, regulate and police users' groups.

However, the two types of groups face many similar challenges:

- Risk of political interference and domination by the local elite.
- Ensuring real awareness of responsibilities.
- Difficulty in ensuring effective participation by women, and equity of benefits (in the case of FUGs some people may be excluded from membership).
- Developing trust and transparency of procedures, especially with regard to finance.
- Managing internal and external conflict, etc.

It would be useful to analyse these differences further, this could include studies at Sundari where there are both a water users' and forest groups.

5 Irrigation Management Reforms in China

5.1 Introduction

This section covers preliminary findings from brief visits to two provinces in the North-West of China. This is section is thus less detailed than that on Nepal. More detailed studies in Ningxia are in progress, and are planned to be undertaken shortly in Xinjiang. These provinces have introduced reforms more recently than some other provinces in China, particularly in the Yangtze basin, but significant progress has already been achieved and this experience should be valuable elsewhere.

5.2 Reforms in Ningxia Hui Autonomous Region

5.2.1 Introduction

A programme of irrigation management reform was introduced in Ningxia in 1999. This focuses on management of tertiary units, for which two basic models have been developed, here referred to as Water Users' Association (WUA) and contract models. These are very different in concept but the practical details are remarkably similar.

Management of the main system is equally important, particularly since a key objective of the reforms is to reduce water use. It is unlikely that users will limit their use of water, to the extent desired, as result of increased participation at tertiary level and higher water charges. There may be some scope for improving main canal operation by involving users in the planning and management of these canals through WUAs, federations of WUAs, water supply companies or other means. Further control on water use requires a system of restricting allocation to each irrigation district. This is not reviewed further in this report.

The objective of the reforms is to save water, with the additional benefit of increasing revenue for O&M without increasing the burden on the farmers. The latter objective may seem to be self-contradictory but it is intended that water saved in one tertiary can be used (and sold) elsewhere, and also to increase the productivity of water. These reforms were planned following visits by the provincial WRB to WUAs in Jiangsu and Hunan.

Unlike in the sites visited in Jiangsu and Hunan, there have been few management reforms at a higher level in the system, such as the introduction of autonomous water supply companies (WSCs), nor are there plans to do so. No information is available on the relative significance of losses at main system and tertiary level, but main system management on large scale canal irrigation such as this is often more important than tertiary level management (Chambers, 1988).

> *Water users' associations*: A users' committee of 5-7 members, comprising chairman, treasurer and general members selected from the farmers within a tertiary unit form an association registered with the human resources bureau and take over responsibility for management of the tertiary canal. Their responsibilities include collection of irrigation fees and distribution of water within the tertiary unit. They pass part of the fee collected to the Irrigation District. Farmers are represented in a general assembly, and select the committee members.
>
> *Contract management of tertiary units*: One person is awarded a contract to collect fees and to manage water distribution within the tertiary canal. This contract may be with a new WUA or it may be with the previous management organisation (village, township or irrigation district). He is required to pay part of this fee to the ID, township, village or WUA and he retains a

management fee to cover his expenses and profit. The contractor is required to pay a security to the village as well as an advance on water fees. The farmers may be involved in selection of the contractor, or he may be selected on a competitive basis with the contract awarded to the one bidding the lowest management fee.

The similarity between the two lies in the fact that the user committee members and contractors are drawn from the same small pool of people (typically village and canal leaders), and there is little participation by other farmers in either arrangement. The units are defined with hydraulic boundaries but correspond as closely as possible to village boundaries; thus they may comprise one canal, a number of small tertiary canals or discrete parts of larger canals. The offtakes to tertiary canals are operated by the ID who measure the total volume of water delivered and charge accordingly per cubic metre. Fees by farmers are paid according to area irrigated, regardless of actual consumption or even crop grown. However, there is a relation with water use since the fee is calculated according to the consumption over the past three years, plus the management fee.

So far 188 WUAs have been set up and 935 contracts awarded. The provincial WRB stated that the WUA plus contract arrangement appears to be best, but the decision is taken at county level to reflect local aspirations and conditions. The process of reform is seen as beneficial, with the main advantage of WUAs being improved coordination. A water saving of 17% was achieved in 2001 as compared to 2000.

5.2.2 Characteristics of Tertiary Unit Reforms

(i) Introduction

The main features of the reforms are that management is localised and that fee collection is strengthened and linked to actual water usage. Management is however not highly participatory, nor is this seen as a priority, and the link between water charges and volumes used is relatively weak. Some repairs (gates, canal lining, etc) are usually done before reform of management.

Some general points should be noted:

- The emphasis is on controlling supply rather than managing demand. It is possible that some losses ‘saved’ might in fact have been used productively elsewhere.
- Many traditional roles are unchanged – some of these are rather bureaucratic or confused.
- Participation is less of a priority than improving efficiency.
- There is no change to systems of conflict management (the contractor has no role, and refers to village/township, although he may be able to resolve some minor issues).

This report is based on visits to provincial and county water resources bureaux and 5 tertiary units, and discussions with township, village, WUA and contractors. Salient details of the tertiary units are given below.

Table 5.1: Tertiary Units Studied in Ningxia

Name	Township / County	Irrigation District	Type	Area (mu)[1]	Layout	Water Charge
Xing Tan	Dong Yue ZhongWei	Weining LB	WUA	4,300	Tail of 7,500 mu canal (1 village)	¥ 35 / mu
Kaige	Zheng Wio ZhongWei	Weining LB	Contract (1 yr)	6,500	One canal (3 villages)	¥ 30 / mu
TaiPing	Shekong Zhongning	Weining RB	WUA + Contract (1 yr)	3,300	4 canals (1 village)	¥ 38 / mu
Ton Zhang	Chao Yuan Zhongning	Weining RB	Contract (1 yr)	1,795	1 canals (1 village)	¥ 45 / mu
Yong Gu	Yong Gu Yinchuan	Qingtongxia	Contract (3 yrs)	12,000	1 canal (4 villages, 2 counties)	¥ 32.65 / mu

(ii) Contract Management

This option has advantages for contractors, which may be one reason why it is so popular. It is also beneficial to the end user since it results in a single relatively well-defined management organisation at a local level for each tertiary canal. However, there are a number of advantages and disadvantages to the contracting organisation, contractor and user and thus these will be reviewed in turn.

Contracting Organisation

The responsibility and hassle of fee collection is avoided, and is separated from other local revenue collection. Water allocation, minor (emergency) maintenance and minor dispute resolution is delegated, but responsibility for maintenance (both using village or township funds for major works, or unpaid labour contributions for annual canal cleaning) as well as conflict resolutions remains. In theory the township is excluded from management and would lose the corresponding revenue, and their attitudes to reform are seen by the provincial WRB as a significant risk. However, in many if not all cases, they retain a role and are paid either directly by the contractor or via the ID. This means that a significant potential advantage is lost, but there is little alternative until other arrangements for maintenance are developed and the township can be persuaded to relinquish this role.

Contractor

The main incentives to the contractor are to:

- Save water to minimise payments to ID, which are made on the basis of actual volume delivered.
- Ensure they provide an adequate delivery to farmers so that they are willing to pay the fee. In one case they were reported as even pumping water to a small area of high land.

These two factors are seen as providing a strong incentive to the contractor to manage water distribution and monitor water flows carefully. However, the amount retained by the contractor is

[1] 15 mu = 1 hectare

only a small proportion of the total fee – about 5% or less. There is thus little scope for making large profits and the contractor must ensure that the farmers are satisfied with water deliveries – this makes the system better than it might intuitively appear to be.

There are some disadvantages:

- The contract is of short duration (usually one year, may be up to 3 years) so the contractor only undertakes essential maintenance to ensure no water is wasted.
- There is little participation by the farmers, and water allocation relies on informal understanding between the contractor and farmers (the contractor is in general a farmer in the tertiary unit).
- The contractor may ask the ID to cut off supplies after sufficient water has reached the official tertiary unit command, but excess water may in the past have been used beneficially by other farmers.
- The contractor may cut delivery to marginal land which is difficult to irrigate, if the cost he would have to pay to the ID for the volume of water needed to irrigate this exceeds the fee that the farmer would pay (this might apply to the tail end of leaky canals or slightly high land for which greater water depth is needed in the canals).
- The contractor invests and takes risks, but he has potentially large profits.

Farmers

There are some disadvantages, listed below, which may seem significant and may reduce the impact on achieving the stated objectives, but they may be less important than the main advantage is that there is a single point of management at local level for routine activities. Other agencies only become involved for maintenance and resolution of more contentious disputes. This simplification of responsibilities is very important.

- No direct incentive to farmers to save water, individually (their charges are per unit area, averaged over the tertiary unit and unrelated to actual consumption or even crop grown).
- There is a weak incentive to farmers to act collectively to reduce water use, since the profit from saving will go to the contractor. This will be reflected in lower charges in subsequent years, but there will be a slow response as the charges are based on the average of the past three years.
- Farmers have no recourse if the contractor fails to deliver water, except that they can (*in extremis*) refuse to pay.

(iii) Water Users' Associations

The WUAs comprise a committee of 5 – 7 members, selected by consensus in a general assembly of farmers. Their tasks are the same as for the contractor; but with the difference that the profit would remain with the association for the benefit of the farmers rather than the contractor. In practice, the difference may be small since the salaries of the WUA members are similar to the contractor's management fee.

Often the committee members are village leaders, and thus the WUA may not be a very independent organisation. More importantly, the WUA is defined by canal command rather than village boundary. However, there is clearly scope for enhancing awareness and understanding of the concept and functions of WUAs.

(iv) Water Charges

Water charges to farmers vary from ¥ 30 – 45 /mu, which is equivalent to £ 35 – 55 / hectare. This is calculated in advance on the basis of the average of the past three years water use, minus 5%. The bulk charge paid by the contractor or WUA is calculated according to actual (measured) water diversions through the tertiary head gate at the rate of ¥ 0.012 / m^3. The increased transparency in collection process, whether by contractor or WUA is seen as a major benefit of the reforms. This is achieved by separating the water fee collection from other village level fees and taxes, and thus the contract arrangement is as effective as the WUA in this regard.

In addition to these water charges which are largely (95%) for payment of bulk water charges, farmers are also obliged to undertake maintenance of the tertiary canals (in labour, but equivalent to 15 ¥ / mu or £ 18 / ha) – this seems a high figure but is presumably due to the high sediment content of the water. There is also a system of irrigation operators in some places, paid by the farmers to manage irrigation for them at a cost of about ¥ 1 / mu (£ 1 / ha).

The make of costs to farmers is thus (in pounds per ha)

Bulk charge		35 – 55
Tertiary Management		0 - 3
Maintenance		18 (as labour)
Irrigation		0 - 12
Total	**UK £**	**53 – 85 / ha**

Typical rice yields are 9 tonnes/ha, so the net returns are about £400 / ha. Thus water charges are 15-20 % of net returns, or 5-7 % of gross production costs. O&M costs are likely to be of the order of £ 20 per hectare, indicating that water charges are sufficient for full O&M cost recovery and a significant element of capital cost recovery.

These fees are rather higher than those reported by Groenfeldt & Svendsen (2000), which range from US $ 25 – 77 / ha in Turkey, Mexico, Colombia, Argentina and the Philippines. They also recommend that fees should be in the range of 5 – 8% of gross production costs.

(v) Water distribution system

Water management at tertiary unit level is not very sophisticated and does not require complex skills – it is not seen as a priority problem. One issue is the method of control. In most tertiary units inspected, there were slide gates to control flow into sub-laterals from which water was released to the field by cutting the banks. There are few cross-regulators, and the canal needs to be operated full, or water level raised by placing timber checks. This is likely to contribute to the wastage as well as inequities in distribution. There is an interesting system of communal irrigators – who are paid by individuals farmers to irrigate their fields for them. They operate the field canals and divert water onto farmers' fields. This system has been in place since around 1990 and is used particularly where improved (water saving) field irrigation techniques are used. Gao Hong (2002) reports that this has been refined if there is a`WUA by imposing penalties for poor performance. The irrigators are generally chosen by, or with the approval of, the village leader.

Given the bulk charge of ¥ 0.012 / m^3 and the stated bulk water fees, the water use can be calculated as 3 – 5 l / sec / ha. This is a very high figure when compared with the consumptive use by rice and wheat and confirms that there is significant scope for further savings or that there is considerable reuse of losses which is not accounted for.

Some measures that have been introduced are rotation of sub-laterals, and water saving irrigation techniques (wetting/drying for paddy). There appear to be no formal procedures for water allocation planning, but contractors and WUAs do develop plans and ensure timed deliveries to farmers. They request the ID to deliver specified volumes and durations through the tertiary offtakes to suit this schedule. The relative roles of WUA, FWM and ID in planning water allocations were not entirely clear, and probably vary from canal to canal. Direct farmer involvement appears to be relatively low. Operation of the tertiary gate remains the responsibility of the ID.

(vi) Maintenance

Maintenance is undertaken by a number of different agencies, and the responsibilities are not well-defined. The province arranges maintenance before management reform, and possibly for some time afterwards, townships undertake some periodic maintenance, villages organise canal cleaning, and WUAs or contractors do emergency maintenance to ensure continued operation and to minimise losses during the irrigation season. The village but not the WUA has authority to organise village labour which is required for canal cleaning (as part of their 20-day annual compulsory labour contributions).

The townships regard themselves as the *de facto* owner and to have the prime responsibility for maintenance, but ownership of these collectively built tertiary units and thus responsibilities for maintenance remains unclear and contentious.

5.2.3 Potential Improvements to Tertiary Level Management

(i) Farmer Participation and Incentives

Farmers apparently see little reason to participate in management, and they have little incentive to do so. A number of potential measures can be identified. For example, the contractors could be selected by farmers via a WUA rather than on price, with the management fee structured to give both parties an incentive:

- There could be a rebate on payments by farmers proportional to actual savings in water volume rather than all the benefit going to the contractor.
- Charges could be structured to vary according to crop type (at present the assumption is that farmers grow wheat and rice in alternate years and thus a single rate is adequate, but this weakens the link between consumption and water charge).

There needs to be an accurate and agreed database of landholdings to be used as a basis for water charges and maintenance contributions. In many cases, this is based on 1980s land allocation, which is often out of date. This has been updated in some places.

(ii) Clarification of Responsibilities

The reforms are currently focused on specific tasks – fee collection and water distribution. Responsibilities for these are now defined, although there appears to be some overlap in roles for planning, implementing and monitoring water distribution where FWMs are also involved. There are also a number of other important tasks that are still confused, particularly related to maintenance for which several agencies are involved.

Responsibilities for the key functions can be summarised as:

- Operation – FWM, (WUA or contractor)

- Routine maintenance – village
- Major repairs - WMS
- Finance – WUA or contractor
- Conflict resolution – (WUA or contractor), village
- Representation at main system level - (WUA or contractor)

It can be seen that the WUA responsibilities are at present relatively small, but they fit into a broader system that can be further reformed. Options for these reforms need to be considered in the light of the overall objectives and other ongoing rural reforms.

(iii) Water Distribution System

There is scope for water saving, although the impact of this on irrigation in adjacent areas needs to be considered. In some places losses may be reused for irrigation elsewhere. Measures could include:

- More accurate water allocation plans, and strict adherence to these.
- Better control of water level, by rotational irrigation in canals where command at low discharge is a problem.
- Rotation of sub-lateral canals.
- Improved on-farmer water management.

(iv) Flow Measurement

If charges are based on volume used, then measurement needs to be reliable and trusted by farmers.

Flows are measured using a depth-discharge relationship for the head reach of the canal. This relationship is established by current metering. In a well-defined channel, such as those seen, this can be expected to be within $\pm$ 10%. There would be further reduction in accuracy if there is any sediment in the canal. 10 cm sediment in a typical tertiary channel would reduce discharge by about 10% for a given water level. If the water level needs to be ponded close to the measurement point, this would reduce the discharge further and make the method of measurement invalid. Such checks should be removed before recording the water level.

Consistency may be almost as important as absolute accuracy, and thus provided considerable care is used the method should be acceptable (however weed growth in unlined canals will need particular attention). As so much depends on the measurement, it is likely that the contractors are conscientious in this, but they should be aware of the potential inaccuracies and measures to minimise these. Farmers should also be aware of the methods and the issues related to accuracy of measurement.

(v) Technical Support

The programme is very new and has been introduced with as yet a relatively low level of support, and relatively modest targets. Some training and technical assistance has been given by counties and townships, with guidance from the provincial WRB.

Experience on the WB supported projects (Yangtze Basin, Integrated Agriculture Intensification, Tarim, etc) as well as internationally suggests that strong and continued technical support to farmers and local level government agencies is important to establish and sustain reforms – this should include awareness of the reforms and their purpose, as well as technical, administrative and managerial skills.

5.3 Irrigation Management Reform in Xinjiang, China

5.3.1 Introduction

With its extreme climate and limited water resources, Xinjiang poses great challenges for irrigation management. The total irrigated area is more than 2.6 million ha, and it is the main cotton producing area of China. Participatory irrigation management is clearly only part of the solution to the diverse problems facing irrigated agriculture in the region, but it is an important innovation which is considered beneficial (Ministry of Water Resources, 2002). The policy of water supply to households, whereby water should be delivered to individual households and paid for according to the volume received is a key feature of this. Under the Tarim Basin II Project, a pilot programme for SIDDs has been established, comprising one WSC and one WUA in each of the five project prefectures.

5.3.2 SIDDs in Xinjiang

A WSC has been set up for the Kuche-Tarim (KuTa) branch canal, in Bayingol, which serves 12,000. Initially one WUA has been set up and planning is in progress to expand this following the successful pilot study (Hehai, 2000). The existing WUA serves 400 ha for 280 households. As improved control and accurate flow measurement was seen as essential, these canals were improved at a cost of around £ 200 / ha including canal lining as well as control and measurement structures. Measurement is done down to approximately 5 ha units using prefabricated cipolletti weirs. The rotational system is designed so that farmers receive the entire measured flow when it is their turn for irrigation.

The system is new and there is little need for rigorous maintenance in the short term, but effective maintenance systems will need to be introduced if the system is to be sustainable. However, it is apparently already very popular – particularly for the improvements in physical condition and the ability to measure (and pay for water) actually received.

Where measurement is not possible (for example, if weirs are damaged, submerged or otherwise non-functional), a proportional allocation based on area below a higher measurement point is used. Payment for losses is not clear, since the WUA should pay for flow measured into the lateral but in fact just pass on the fees collected on the basis of flows measured at sub-lateral level. In these newly lined canals the losses are probably small compared to the errors in flow measurement.

Water charges are calculated according to the national standard formula (depreciation, major repairs, O&M and bulk cost of water), are collected by the WUA and paid entirely to the township. The calculation includes elements for maintenance, which is the responsibility of the WUA, as well as for depreciation, which should also logically be retained by the WUA. They are not allowed to keep this, but as a special dispensation the WUA is allowed to retain 1% of the fees collected. They do have some alternative sources for maintenance funds – direct labour contributions, additional collections as required, or village funds. It appears that most maintenance only involves labour, with a small amount required for greasing gate spindles. Being newly rehabilitated, the system is in good condition, but problems of damage to lining (leaking joints, vegetation damage) and gates (broken spindles) and measurement weirs (chipped concrete, unclear markings) are already emerging.

Financial aspects are strongly stressed – both the need for cost recovery for O&M / depreciation, and to reduce demand for water by raising prices. These are related but distinct topics, and need to be analysed separately. Improved management of water by collective action within a lateral command, a common WUA objective, is not seen as separate task but a natural consequence of achieving direct measured supplies to individuals. Cooperative action is thus seen as unnecessary, beyond that which is said to be already adequately covered through existing village level organisations. This approach assumes that measurement is physically and administratively sustainable.

The Water Supply Company manages the KuTa canal, but the intervening branch canal (Xingping) is managed at county level thus breaking the direct link between the WUA and WSC that is the key feature of the SIDD concept. The WSC is part of the prefecture WRB; it is a discrete unit, but not autonomous or independent. KuTa is one of several main canals offtaking from the Kuche river in Korla. The WSC is not surprisingly locally regarded as less successful than the WUA, since it appears to be little changed from the previous system.

Water charges are lower per unit area in Xinjiang than most other parts of China, but this is partly because of lower water use – the bulk charges in Xinjiang are ¥ 0.018 per m^3 for wheat and ¥ 0.032 per m^3 for cotton as compared to ¥ 0.012 / m^3 in Ningxia. The main crop in Xinjiang is cotton for which the price has dropped sharply (by about one third) since 1997 owing to the abolition of price support. With a yield of 1,360 kg/ha, the net return was £ 170 / ha in 1999 after allowing for water charges of £20 per hectare. The returns to wheat for which the yield is 4.5 tonnes/hectare, are even lower at only £100 / ha despite a lower charge per cubic metre for food crops. Although the water charges are quite a small percentage of the total output prices, they are 12 to 20% of the net returns, and so it is not surprising that there is strong resistance to increasing water charges. In addition to this fee, they undertake maintenance which is valued at £ 2 per hectare

6 Comparison of Reforms in Nepal and China

6.1 Objectives

Both Nepal and China have invested very heavily in irrigation infrastructure over the past 50 years, but the performance has been less satisfactory than had been hoped. Both countries have introduced reforms over the last decade, which require much greater participation by users, to help resolve these problems of under-performance. The situation in each country is different and thus the specific objectives are also slightly different.

In Nepal, the objectives are to reduce government involvement and enable self-financing management; ensure environmental sustainability; encourage traditional forms of irrigation; and increase the role and responsibilities of users (Ministry of Water Resources, 1997). Poverty reduction and efficiency of water use are not specific objectives although these are emerging as issues during the current revision of the irrigation policy (Royds, 2002)

China, particularly the North-west, which is the focus of this study to date, faces much greater water stress than Nepal - water saving is thus given a much greater priority. Reduction of water use by controlling supply and increasing prices to reduce demand is thus a priority in China. Specific objectives from the reforms are to: increase productivity of water; introduce the 'users pays' principle; ensure that fees are transparent and used for maintenance; and to encourage Irrigation Districts to provide a reliable supply of water (Li and Liu, 2002).

Both countries face considerable pressure on resources for maintenance, and thus reduction of Government recurrent expenditure is a priority in both countries. In both cases the policy has been developed by the Government itself rather than in response to demands by users of irrigation systems.

6.2 Progress of Reforms

Considerable progress has been made in both countries, which are regarded internationally as relative leaders in the field of PIM.

Nepal has applied the policy both to support traditional farmer-managed irrigation and to transfer government-managed irrigation to users. Both approaches are effective when adequately supported, but it has proved difficult to make new WUAs into independent, sustainable organisations. A number of different approaches have been attempted but there is no clearly successful method yet.

Participatory management has been introduced relatively recently to the two provinces reviewed in China. These are still small-scale, new programmes and it is too early to evaluate them formally. This level of participation in management does appear to be beneficial, although this cannot be quantified.

Despite the good progress to date, some specific weaknesses in the approach to participatory management can be identified.

(i) Nepal

At current prices and yields, there are very low returns to irrigated cereal crops. This makes it very difficult to justify investment in management of large-scale irrigation in Nepal – farmers are thus unwilling to spend money or develop community organisations. Small-scale irrigation where the costs (in all senses) are lower and where high value crops can be grown over a larger proportion of the irrigated area are more likely to be viable. Irrigation is both subsidised and under-funded, with water

prices charged to the users being so low that the Government has little incentive to improve management.

WUAs are intended to be democratic institutions, which will ensure equitable distribution of benefits. They rarely achieve this, and are generally weak organisations. They are often dominated by local elites. In some cases this reflects traditional management, which was controlled by a small number of landlords, but is not effective in ensuring equity of benefits. Indeed many question whether that is even possible (Pradhan, 2000). Some traditional irrigation, particularly in the hills, is more egalitarian but these are generally on a small scale (less than 100 ha).

WUAs are usually set up to help plan or manage rehabilitation and they do not see long-term management as an important task. In any case, the benefits to irrigation are small and often do not depend on strong performance by the WUA for the first few years after completion.

(ii) China

The WUAs in Ningxia and Xinjiang have limited autonomy and in practice are often closely linked with the village administration or with the water management station. This has some advantages since the village has the authority to manage community labour, which is needed for canal maintenance, but it also leaves the WUA with a relatively limited role. This is particularly related to collection of fees.

These WUAs manage small parts of very large irrigation schemes. They are thus dependent on effective management of the main system. They have very limited scope to improve their situation unless the main system is also improved.

6.3 Differences Relevant to Irrigation Management in Nepal and China

The irrigation reform programmes in both countries are designed to tackle the same underlying problems of under-performing irrigation, with wastage in some areas and excess in others. Both rely on increasing public participation in this, and need to break down the widespread perception that irrigation management is the Government's responsibility. Both programmes have a similar basis, but have evolved independently and adapted to suit local differences. Some cross-fertilisation has taken place with the World Bank being a key supporter of the process in both countries. However, despite these common features there are a number of significant differences.

Agriculture in North China is totally dependent on irrigation, whereas in Nepal water is mainly required for supplementary irrigation of monsoon crops. Winter crops in Nepal are grown on residual moisture with very limited irrigation. Spring crops are dependent on irrigation, but the area grown is small. For a number of reasons, yields are much lower in Nepal than in China. Paddy yields are typically less than 3 tonnes per hectare, even with irrigation, as compared with 9-10 tonnes in Ningxia. The loss in yield without irrigation in Nepal varies from year to year but on average is less than 25%. The net benefit to irrigation (for rice plus wheat) in Nepal was estimated at around NRs 7,000 per hectare (£70 / ha) in 2001 (HR Wallingford, 2001). The net benefit in Xinjiang ranges from £100 - £170 according to crop grown.

Water charges are £50 per ha in Ningxia (including labour contributions for maintenance and payments to common irrigators) as compared to £20 in Xinjiang and only £1-2 per ha in Nepal. The relatively low charges in Xinjiang reflect its special status and the high proportion of ethnic minorities, but are still an order of magnitude higher than in Nepal. The charges in Nepal are nominal and barely cover collection costs.

The irrigation schemes in China are much larger than those in Nepal. This clearly makes them more complex to manage, but the water charge in Nepal, even if collected in full, would be quite inadequate.

The management reforms in Nepal are always associated with physical rehabilitation. In most cases, the WUAs are set up first and involved in planning the rehabilitation. This improves the efficiency of the rehabilitation, but means that the WUA is mainly focused on this rather than on its long term role. This is the case in Xinjiang also, but in Ningxia the reforms have been undertaken independently of physical works.

Attitudes to participation are very different, and this is clearly a new concept in China, which affects attitudes to management reform. There are many cultural constraints to broad participation in irrigation in Nepal, but the nature and impact of these are rather different from China.

6.4 Lessons that can be Transferred

There are many problems which both countries face, and which have not yet been resolved. However, there are also aspects that appear relatively successful in one country but which have not been attempted in the other.

Decentralisation of management appears beneficial in both places. Even without any formal transfer of responsibilities, any involvement of users makes the management more responsive to their needs. If decision-making is devolved also, then there is an opportunity to distribute the benefits more equitably but there is no reason that this should happen unless the WUA is well-regulated and fully accountable to its members. There are many reasons for reforming irrigation management, and the type of reform should suit these objectives. There needs to be a clear understanding and agreement of what these are. This may appear self-evident, but can easily be over-looked as there are so many stakeholders and conflicting requirements.

Cooperation on the scale needed to manage large-scale irrigation is extremely demanding and will be difficult to sustain without a strong incentive. This will only occur if there are good benefits from irrigation (and more specifically to well-managed irrigation) – this is a major weakness on many projects in Nepal. WUAs can only be sustained in such places if productivity can be increased.

Distribution of water within an area managed by a WUA is often difficult, as they do not have the capacity to develop and enforce a water distribution plan. Some FMIS in Nepal have very strict allocation with carefully made proportional weirs. Policy in Xinjiang is to monitor the actual volume of water delivered to each farmer. These approaches are very popular as they make it easy to check how fair the allocation of water is. Charging for water according to volume used and hence reduction in demand is probably less important than improving transparency of distribution. It is difficult to find appropriate methods for this, but some progress has been made.

The system in China is for a fairly rigid demarcation between WUA and higher level management. This makes definition of roles easier, but gives the WUA little influence on how much water it receives it. A more flexible system is used in Nepal; this gives the WUA more influence at a high level but results in greater difficulty in defining responsibilities.

A system of common irrigators is used in Ningxia – these are people paid by users to manage irrigation for them. Most (but not all) farmers in a WUA use them. Since many farmers employ them, they are able to allocate water relatively impartially. However, they are still subject to pressures to give more water to influential people, so this system may not work so well in areas of greater water scarcity.

Another innovation in China is the use of contractors for management. This is unlikely to work in Nepal as long as water charges are low, since the contractor would make insufficient money, but it would be worth considering if charges can be increased. It may then be necessary to find an alternative means for subsidising irrigation.

7 Selection of Sites for Detailed Studies in Nepal

7.1 Introduction

The objective of the second phase is to study schemes throughout an irrigation season in order to identify ways of improving the governance of the schemes using techniques which can then be applied elsewhere.

The research will be designed to test the hypothesis that water users can improve management of water resource systems if they are helped to form well-governed management institutions which correspond to local requirements rather than in accordance with a national or international standard, and are established within a sound legal and regulatory framework.

In this context, good governance includes, *inter alia*:

- Effective local participation (including all sections of the community) in establishing management arrangements.
- Clearly defined and agreed objectives, rights and responsibilities.
- Transparent procedures, ensuring adequate trust by the users in the WUA.
- WUA autonomous, able to take its own decisions and act independently.
- WUA accountable to its membership and externally.
- Equity in benefits resulting from participation in management (including enhanced benefits to poor or otherwise disadvantaged groups).

In order to carry out action research, there need to be some expected benefits for the local participants, which they perceive at the outset to be of some value to them. Establishment of sustainable management should in itself be a strong incentive, given that a major investment in infrastructure has recently been made, but the farmers may have little confidence at the outset that it can be achieved. Thus more tangible short-term incentives may be required. This may include helping establish or strengthen links with other agencies who can help in improving agriculture in a wider sense, but these will need to be specifically identified in each case.

The essential component of this is a series of participatory studies with stakeholders on a wide range of issues. Careful selection of sites for this study is important to ensure that we do not choose schemes which are easy to manage, or which have special features which make them unrepresentative.

We envisage selecting schemes from the following categories. We will focus on the first three categories, but will draw on successful experience from the fourth category.

- Large-scale AMIS which are moving towards joint management, with support from various programmes.
- small-scale AMIS which are traditionally under-resourced, under-performing and excluded from many development initiatives.
- FMIS, particularly where there are several in a single river basin, or where population pressure, changes in local government, urbanisation, changes in water use patterns or interventions on individual schemes may be undermining traditional overall arrangements.
- Successful FMIS which are coping effectively with water shortage and changing requirements, in order to identify key features of functional users' organisations.

The selection of schemes will be from those studied in Stage 1 or where similar information is available from previous comparable studies.

7.2 Criteria for Selection

The main criteria for selection of sites have been proposed as follows:

- Farmer interest in improving management, where the benefits of irrigation are sufficient to justify their involvement.
- Condition such that scheme is operable, but not performing to its full potential due to some deficiencies in O&M.
- Of a scale to require formal, systematic management (typically greater than 500 ha in *tarai* or 250 ha in hills).
- Majority of farmers unable to produce sufficient grain for their households.
- Water shortage, such that irrigation is needed for more than supplementary monsoon irrigation.
- No on-going project for major rehabilitation, or expectation of one in the immediate future.
- Range of different existing management arrangements, eg
  - Part of large AMIS or joint managed scheme
  - Complete small AMIS or turnover scheme – these are traditionally under-resourced, under-performing and excluded from many development initiatives
  - Large FMIS (or group of smaller FMIS in a single river basin), preferably with a situation of changing use or where population pressure, changes in local government, urbanisation, or interventions on individual schemes may be undermining traditional overall arrangements
  - Successful FMIS which are coping effectively with water shortage and changing requirements, in order to identify key features of functional users' organisations
- Security situation such that long term field work is likely to be possible

The small number of potential schemes makes more subtle selection criteria impractical and unnecessary. Water availability is variable on the schemes, but limits performance to some extent on all and thus there is potential for improving efficiency. To avoid lengthy delays during initial registration of a WUA, there should be an existing users' association with sufficient legal authority to collect fees. This applies in all these cases.

The security situation is of particular relevance since the research is concerned with decentralised management, which is often associated with reduced investment by the central government and a requirement for users to contribute more. This is politically sensitive, even though the fundamental reason for decentralisation in this context is to improve management, increase local powers and decision-making roles, and reduce poverty.

The 16 schemes studied, together with four others with previously studied, can be summarised against these criteria as follows:

Table 7.1: Selection of Schemes for Stage 2

Scheme	Condition	Perfor-mance	Size (ha)	On-going project ?	Farmer Interest	Food Prod > 6 mths / yr	Constructed by	Management type	Supple-mentary irrigation?	Changing needs	Security
Kankai	*Good*	*Good*	*7,000*	*No*	*Yes*	*No*	*Agency*	*AMIS (JM)*	*No*	*No*	*??*
Sunsari Morang-2	Good	Fair	15,000	(No)	Yes	No	Agency	AMIS / (JM)	No	No	OK
Sunsari Morang-1	Good	Fair	9,750	(No)	Yes	No	Agency	AMIS / (JM)	No	No	OK
Sundari	Good	Fair	1,200	No	Yes	No	Farmers	FMIS	No	No	OK
Hardinath	Fair	Poor	4,000	Yes	Yes	No	Agency	AMIS	Yes	No	OK
Bighi	Fair	Fair	1,000	No	Yes	No	Farmers	FMIS	Yes	No	OK
Bagmati	Good	Poor	19,000	Yes	Yes	No	Agency	AMIS	Yes	No	No
Jhaj	Poor	Poor	2,000	No	Yes	No	Agency	AMIS	Yes	No	No
Imriti	Good	Good	700	No	Yes	No	Farmers	FMIS	No	No	OK
Aruwa Kachaura	Good	Good	800	No	Yes	No	Farmers	FMIS	Yes	No	OK
Khageri	*Good*	*Good*	*2,800*	*(Yes)*	*No*	*Yes*	*Agency*	*JM*	*No*	*No*	*OK*
Tilawe	Fair	Fair	2,800	No	Yes	No	Agency	AMIS	Yes	No	OK
Egharamauja	Fair	Fair	1,500	No	Yes	No	Farmers	FMIS	No	No	OK
West Gandak	*Poor*	*Poor*	*10,300*	*(Yes)*	*No*	*No*	*Agency*	*TO*	*Yes*	*No*	*OK*
Marchwar	Good	Fair	2,950	No	Yes	No	Agency	TO / JM	Yes	No	OK
Rajapur	*Good*	*Good*	*12,000*	*No*	*Yes*	*Yes*	*Farmers*	*FMIS*	*No*	*No*	*No*
Tika Bhairab	Fair	Fair	700	No	Yes	No	Agency	FMIS	No	Yes	OK
Mahadev *khola*	Good	Fair	450	No	Yes	Yes	Agency	FMIS	No	Yes	OK
Bijaypur	Good	Good	1,280	No	Yes	No	Agency	AMIS	No	Yes	OK
Begnas	Fair	Fair	580	No	Yes	No	Agency	AMIS	No	Yes	OK

The current political environment, with the 'maoist' movement affecting some projects directly, unclear arrangements for local government after expiry of their elected term, and national elections scheduled for November 2002 will clearly have some impact although we hope this can be mitigated by careful choice of schemes.

As noted earlier, there are many schemes where the benefits of irrigation are relatively small and it would be difficult to persuade users to take on a significantly greater role. A realistic assessment of possible schemes for Stage 2 includes

- Small AMIS – Kankai or Bijaypur
- Part of Large FMIS – Sunsari Morang Stage 2 or undeveloped areas outside Stage 3
- FMIS with emerging conflict in a river basin - Girwani *Khola* or Kamala Uttarayani
- Sustainable FMIS – Imriti or Sundari.

The nature of any possible intervention on these schemes in the present context will be carefully assessed with the users.

8 Conclusions

8.1 Introduction

The irrigation policy in Nepal gives a strong emphasis to participatory management. Accordingly, WUAs have been very widely promoted: they have been established at some stage on almost all agency-managed schemes and on farmer-managed schemes where there has been any investment by the Government or other external agencies.. The establishment of WUAs has, however, been externally promoted and associated with a rehabilitation programme. They have been given little long-term support, and few continue to function effectively. There are a number of reasons for this:

- Lack of understanding of the real function of WUAs for water management, or an unwillingness to accept this role.
- Unrealistic expectations for farmer involvement on supplementary irrigation schemes, where the benefits are relatively small.
- Ill-defined functions or division of responsibilities between users and government.
- Persistent under-funding for O&M.
- Weak relationship between management performance and project benefits.
- Inability of WUAs to work effectively until large-scale problems are resolved.
- Inadequate systems for conflict management, and inability to enforce them.
- Unrepresentative WUAs, often building on modern political structures or dominated by local elites rather than traditional community management arrangements.

In many cases irrigated areas have been overstated, usually as part of the justification for rehabilitation. This means that many beneficiaries gain little from the project although they may have been obliged to contribute. It also means that the true project boundaries are ill-defined, there is no accurate database of members, and there is an inadequate resource base for O&M.

8.2 Agency and Joint Managed Schemes

The agency and joint-managed categories are considered together since there is so much overlap in practice. However, the extent and formality of joint management varies significantly. Under joint-management, WUAs are fully responsible for management of the low levels of the system and work jointly with DOI in managing the main system. This concept is very different from that adopted for irrigation management transfer in China and many other countries, where there is a single point of transfer of responsibilities. It has advantages in enabling effective participation in the main system (eg at SMIP, where the WUAs are involved in pre-season water distribution planning and adjustments to the main system during the season), but it creates a risk of confused or overlapping responsibilities. Where the WUA is involved in contracts with DOI they may even face a conflict of interest in quality control.

These systems were designed for centralised management and there are some difficulties in both decentralising this and making management less technically demanding (for example in controlling flows or water levels). It has proved difficult to get sufficient awareness of the reasons for transferring management and agreement with the objectives of IMT, and thus the process of setting up joint-management agreements has been slow. A real commitment to long-term management has been achieved on very few schemes, and it is apparent that the regular meetings of WUAs do not focus on this. They frequently take decisions on matters for others to undertake, but rarely on issues that they should implement themselves. As some of these schemes are large, a complex structure of WUAs is needed but this is difficult to manage as there are so many interfaces – the unclear role of the WUC on SMIP is a clear example of this problem.

Although there is little evidence of WUAs managing canals larger than tertiary canals (say up to 100 ha), users can still have an effective input into higher level management, particularly in planning O&M. At SMIP, their direct responsibility extends only as far as 28 ha watercourses (15-50 farming households, because of land tenure arrangements and fragmentation). There are some anomalies in this approach – for example at SMIP, the coordinating committee at secondary canal level is the registered legal entity and able to collect resources, but it is the subsidiary watercourse groups that are directly responsible for their canals yet they lack the authority to do this. Probably the best performance of joint management is at Khageri where WUAs manage 250 ha secondary canals. Although the WUAs do manage water distribution within these areas, this is on an informal basis and is not equitably shared. Attempts to impose distribution, for example using the 'structured system' as at SMIP have not succeeded as the users do not understand or agree with the basis for this.

In both these cases, users also influence main system management as there is a relatively clear understanding of the responsibilities of both DOI and farmers and both parties have the resources to carry out their duties. However, there needs to be a system of monitoring as failure by one party affects the other (eg neglect of routine maintenance by a WUA will lead to emergencies to be resolved by DOI, or unreliable water supply in the main system compromises tertiary-level distribution)

Elsewhere the role of the WUAs is not so well understood or defined and they act more as a means of communication between government users or as pressure group (eg at Bagmati). Such a role is not sustainable, as can be seen by their poor performance at Tilawe. The large projects partly financed by the World Bank have used a common format, with a series of coordinating committees at high level for joint management with low level groups with direct responsibility for certain activities. Local government has less involvement in these schemes than it does in farmer-managed irrigation as farmers are more likely to rely on DOI to resolve their problems or cover financial shortfalls. However, control of WUAs is still keenly contested. This is both because they seek to be involved in the initial rehabilitation, and because it is important for developing a local power base – leadership of a WUA has a wider significance than irrigation.

Most medium-scale projects are included under the ADB-supported Irrigation Management Transfer Project (eg Hardinath), or are being developed by DOI in a similar way (eg Jhaj). Some of these projects were originally developed to suit availability of land and water, rather than because of a true need for irrigation. They were designed for extensive irrigation of rice and are insufficiently flexible to be used for other crops. These are long-established but under-performing and under-resourced agency-managed schemes; they are extremely challenging in terms of developing effective user-participation.

Many of these schemes have a relatively low demand for irrigation, since they are primarily for supplementary irrigation (particularly at the time of paddy land preparation). There is little incentive for farmers to invest in developing cooperative arrangements unless the benefits are greater than this. Significant areas of dry season irrigation (spring paddy and vegetables) are found in Kankai, parts of Sunsari Morang, Hardinath and Khageri in the *tarai* and Bijaypur in the hills – these schemes are not surprisingly the best-managed. There are relatively few schemes where there is sufficient water for this: these are most likely to respond to IMT. It will be difficult to improve management on projects which are essentially used for protective monsoon irrigation, and these will require methods which are less demanding in setting up community management arrangements.

8.3 Farmer-managed schemes

All of the schemes studied are old but have been rehabilitated in the last 10 years. A striking feature of all of them is that the actual command area is much smaller than the official data indicates. This appears to be because the cost of the headworks in the *tarai* is so great that it can only be justified if the command area is increased, but in the absence of infrastructure, lack of water rights and any basis for extending traditional management this enlargement is not achieved. A common feature is that several schemes (eg at Bighi, Sundari and Rajapur) are combined into one to simplify the intake arrangements. This is problematic and often unsustainable; it conflicts with traditional management,

which relies on keeping systems entirely independent. In the case of the two schemes in the Kathmandu valley (Tika Bhairab and Mahadev *khola*), areas are also reducing because of urbanisation.

There are thus a large number of small schemes, but few are larger than 500 ha. As might be expected, those sampled are generally more intensively farmed than the agency-managed systems as they developed in response to a need for irrigation, although they are generally on small rivers with insufficient flow for spring paddy. Two other features of FMIS are relevant here: their layout is well suited to decentralised management of essentially independent units; and management relies on labour (particularly off-season labour at times of limited alternative employment opportunities) and local materials, rather than cash.

There is a distinction between cooperative and autocratic types of management. The former are more common on the smaller schemes (particularly in the hills) where small communities developed and continue to manage the project. The *tarai* was settled by giving large land grants to *jamindars* (landlords); this land was then developed and farmed by share croppers but all decisions were taken by the landlords. Following land reform this system has been abolished and some of the irrigation has collapsed or is under-performing. Small farmers are then unable to make a satisfactory livelihood from irrigated agriculture and tend to work as migrant labourers rather than invest in cooperative management.

WUAs are only set up where they are required for some interaction with the Government – usually for rehabilitation. This is naturally the focus of their activities and it is difficult to strengthen sufficiently to take on a larger role (as the cost of this is so high). Often they do not even formally take over the scheme on completion of construction, so it remains in limbo. Management often reverts to the traditional system, but they may lack the skills or resources for this – particularly if separate schemes are combined or complex structures are provided. Traditional weirs were leaky so that conflicts between adjacent schemes were minimised, but permanent structures can create new conflicts, for which there is no forum for resolution.

VDCs are often involved directly or indirectly in management. Their role is not yet clear, as Local Governance Act has not been fully implemented in practice and the local bodies were dissolved in July 2002 without setting a date for elections. This is an issue which needs clarification (and which applies to many sectors as well as irrigation)

8.4 Implications for Sustainable Management

There has been considerable difficulty in setting up effective management arrangements in Nepal. A common request is for DOI to rehabilitate the system and manage it well for one or two years and then hand it over to users. Few farmers want to take over management in the belief that they can improve the situation, and the fact that irrigation is heavily subsidised (in practice by almost 100%) makes it difficult for them to do so. In almost every case they want DOI to manage at least the headworks (and thus be responsible for providing water into the canals).

Although there are many successful farmer-managed irrigation schemes, it is difficult to use this experience on new irrigation schemes. Some, probably mainly in the hills and relatively small, operate on a socially equitable basis (Yoder & Martin, 1996). Many were built by large landlords and have evolved into a form of community management after land reform and changes in land tenure. Some, such as Rajapur, are now very large and have been operating successfully for many years but they may retain quite an autocratic form of management. Attempts to change this through introduction of democratic WUAs are likely to be strongly resisted, and Pradhan (2000) regards most attempts to do so as doomed to failure.

Many people do not trust Water Users' Associations to operate honestly and transparently, and they consider them to be less democratic than local government. There are rarely formal elections and it is

generally rich farmers who dominate them. Conversely WUAs lack some legal authority to collect fees and carry out all their functions.

There are several issues which are critical to their sustainability:

- *Clarity of roles* – definition and awareness of objectives, roles, rights and responsibilities; the appropriateness of these to local situation (socio-economic situation, type of agriculture, type/scale of infrastructure, water stress, etc); distinction between decision-making and administrative tasks, relationship with other organisations (including higher and lower levels of irrigation management)

- *Participation* – the extent to which the users participated in formulation of policy and the application of policy to local situation, their participation in the management institutions, how comprehensive this is for different sections of the community and different categories of users, and how well this reflects their interests

- *Autonomy* – the ability to make independent decisions, collect and manage sufficient resources, , appoint staff and act in their own interests etc, rather than depend on external sources or influences, and the process for maintaining autonomy

- *Accountability* – accountability of the organisation to its members, rights of appeal, and the transparency of procedures for ensuring this. How is it regulated and audited.

- *Transparency* – of information, procedures, finances, distribution of water etc.

8.5 Irrigation Reform in China

The reforms in China have a very different starting point, but comparable overall objectives. In the past farmers have not participated in irrigation management and this is a very unfamiliar concept. In many cases they are not active in WUAs because they see little reason to be, and they rely on the committee members to manage the system. However, this still benefits as the management decisions are localised.

The reforms are currently focused on specific tasks – particularly fee collection and water distribution, and the WUA responsibilities are relatively small, but they fit into a broader system that can be further reformed. Options for these reforms need to be considered in the light of the overall objectives and other ongoing rural reforms. Flow measurement is a very important part of the policy. This ensures transparency of water distribution and is aimed at stimulating a reduction in demand. This is a valuable innovation although it has high transaction costs which must be compared with the benefits.

The programme is very new and has been introduced with as yet a relatively low level of support, and relatively modest targets. Strong and continued technical support to farmers and local level government agencies will be needed to sustain these reforms – this should include awareness of the reforms and their purpose, as well as technical, administrative and managerial skills.

8.6 Lessons that can be Transferred

Decentralisation of management appears beneficial in both places. Even without any formal transfer of responsibilities, any involvement of users makes the management more responsive to their needs. If decision-making is devolved also, then there is an opportunity to distribute the benefits more equitably. There are many reasons for reforming irrigation management, and the type of reform should suit these objectives. There needs to be a clear understanding and agreement of what these are. This may appear self-evident, but can easily be over-looked as there are so many stakeholders and conflicting requirements.

Distribution of water within an area managed by a WUA is often difficult, as they do not have the capacity to develop and enforce a water distribution plan. Some FMIS in Nepal have very strict allocation with carefully made proportional weirs. Policy in Xinjiang is to monitor the actual volume of water delivered to each farmer. These approaches are very popular as they make it easy to check how fair the allocation of water is.

The system in China is for a fairly rigid demarcation between WUA and higher level management. This makes definition of roles easier, but gives the WUA less influence on how much water it receives it. A more flexible system is used in Nepal; this gives the WUA more influence at a high level but results in greater difficulty in defining responsibilities.

A system of common irrigators is used in Ningxia – these are people paid by users to manage irrigation for them. Since most farmers employ them, they are able to allocate water relatively impartially, but they are still subject to pressures to give more water to influential people, so this system may not work so well in areas of greater water scarcity.

Another innovation in China is the use of contractors for management. This is less likely to work in Nepal as long as water charges are low but would be worth considering if the basis for subsidising irrigation is changed so that charges can be increased.

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Appendix A: Inventory of Medium- and Large-scale Irrigation in Nepal

INVENTORY OF IRRIGATION PROJECTS

Name	District	River	Area			Water	Main	Type of control		Condition		Management		Date built			WUAs		WUA Federation		Social	Conflicts	Other uses	Related systems	
			Gross	Monsoon	Spring	Supply	Crops	Main	Tertiary	Main	Tertiary	originally	now	Initial	Rehab	Program	Exist	Active	Exist	Active				Irrigation	Other
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
tarai greater than 500 ha																									
Dunduwa	Banke	Dunduwa	1,250	-	-	poor	Paddy	gated	ungated	poor	poor	AMIS	disfunct	1964		INDIA	yes	no			Yadav				
Fattepur	Banke	Groundwater	1,648	Under construction		good	Paddy							1998		IDP/EEU	yes								
Rajkulo	Banke	West Rapti	1,520	Under construction		good	Paddy	gated						1995		NISP/IDA	yes				Yadav				
Lal Bakia	Bara	Lal Bakaiya	1,980	1,980	NA	fair	Paddy	Gated		Good			FMIS		1993	ISP/ADB	yes	fair			mixed				
Imriti	Bara	Imriti	1,300	1,300	1,000	good	Paddy	Gated		good		FMIS	FMIS	Century ago	1994	ISP/ADB	yes	yes			Mixed				
Sirsiya Dudhaura	Bara	Sirsiya	1,200	850	300	2 separate schemes						AMIS	??												
Aruwa Kachorwa	Bara	Aruwa	1,245	700	300	good	Paddy	gated		good		FMIS	FMIS		1999	SISP/ADB	Yes	no			yadav	Water sharing within villages			
Jamuni	Bara	Jamuni	800	800		good	Paddy					FMIS				FMIS									
Thalahi	Bara	Thalahi	800	800		good	Paddy	Gated		Good		FMIS	FMIS		1993	ISP/ADB	Yes	fair			Yadav				
Babai	Bardiya	Babai	13,200	5,600	5,600	good	Paddy	gated		good		AMIS	AMIS	1996	under cons	HMG/DOI	yes				Tharu	Water sharing with d/s FMIS			
Rajapur	Bardiya	Karnali	13,000	13,000	13,000	Good	Rice	Proportional	Variable	Good	Fair	FMIS	JM	old/farmer	2000		yes	yes	yes	yes	Tharu/pahadi	minor	water suppl	no	
Dhodari Taratal	Bardiya	Babai	3,525	2,000	1,000	Good	Paddy	gated		good		FMIS	FMIS	old/farmer	1997	ILC/IDA	yes	yes			Tharu				
Baisahi bandh	Bardiya	Bhada	2,000	2,000	Falls under Babai command area							FMIS	FMIS												
Suryapatuwa	Bardiya	Karnali	1,300	1,000	1,000	Good	Paddy	Gated		good		FMIS	FMIS	old/farmer	1998	ILC/IDA	yes				Mixed				
Bargada Jamti	Bardiya	Babai	1,440																						
Badhaiya Tal	Bardiya	Badhaiya tal	600											166		Minor irrigation									
Narayani Lift	Chitwan	Narayani	4,700	4,700	2,500	poor	paddy	gated	gated	good	moderate	AMIS	AMIS	1985		CIP(ADB)	yes	yes	yes	moderate	migrataed	no		Khageri IS	
Khageri	Chitwan	Khageri	3,900	2,850	2,000	moderate	paddy	gated	Variable	Good	Good	AMIS	JM	1969/DOI	1996	IMTP/ADB	yes	yes	yes	yes	migrataed	no		Narayani Lift	
Anjana tal	Chitwan	Anjana tal	550	550	100	fair	Paddy	fexible		good		FMIS	FMIS	2051/52		ISP/ADB	yes	yes			mixed				
Pithuwa	Chitwan	Kair khola	500	500	100							AMIS	FMIS	1970		HMG/DOI	yes	yes	yes	yes	rahmin/Chhetri				
Patihani Parsa	Chitwan	Kerungaghol	665	400	250	good	paddy	fexible		Good		FMIS	FMIS	052/53		ISP/ADB	yes	yes			Brahmin/Chhetri				
Panchkanya	Chitwan	Panchakanya	600	600																					
Mugai khola	Chitwan	Mugai khola	777																						
Ghoraha-Manpur	Dang	Rapti	500	500	250	good	Paddy	ungated				FMIS	FMIS	old/farmer - limited intervention											
Kodiyasota	Dang	Sano Rapti	500	500	200	good	Paddy	ungated	Praganna command area			FMIS	FMIS	old/farmer - limited intervention				The command area falls into Praganna IP							
Arjun khola	Dang	Arjun khola	500	480	140	good	Paddy	Gated		good	good	FMIS	FMIS	100 years	1991/92	EEU	yes	yes			Tharu	no			
Chauwa Khola	Dang	Chauwa khola	563	500		fair	Paddy	gated		good			FMIS		1995	ILC/IDA	yes	yes			Mixed				
Praganna	Dang	Rapti	5,600	5,600	3,000	good	Paddy	ungated	Under construction			FMIS		old/farmer	going proj	Kuwait Fund	yes	yes	yes	yes	Tharu				
Dangalichhap	Dang	Supaila khola	868																						
Guhar khola	Dang	Guhar khola	700	500	300	fair	Paddy	gated		Good		FMIS	FMIS	1982		ILO	Yes	No			Mixed				
Saundi kulo	Dang	Hapur khola	600	550		fair	Paddy	gated				FMIS	FMIS	1990		HMG/DOI	yes	yes			Mixed				
Satgaule Sirkhola	Dang	Patukhola	525	500		fair	Paddy	gated	under construction			FMIS	FMIS			NISP/IDA	yes	yes			Mixed				
Kamala	Dhanusha	Kamala	25,000	10,000	4,000	fair	paddy	gated	gated	good	fair	AMIS	JM	1975-85	2000-2002	IMTP/ADB	yes	yes	yes	some	mixed				
Hardinath	Dhanusha	Jalad	2,000	1,000	500	Good	Paddy					AMIS		1963-68	IMTP										
Gidda	Dhanusha	Gidda	1,000	8,000	200	good	Paddy	Gated		poor			FMIS												
Murgiya	Dhanusha	Murgiya	600																						
Kankai	Jhapa	Kankai	7,000	7,000	3,500	Good	Rice	Gated	Gated	Good	G (exc gates)	AMIS	AMIS/JM	1980/DOI		ADB	yes	yes	yes	yes	mixed		fish		
Lower Kisni	Jhapa	Ratuwa	1,500	Under construction		Fair	Rice	Gated				New		ongoing/DC	-	*SISP/ADB*	yes	yes			mixed				
Aduwa khola	Jhapa	Aduwa khola	600	600		Fair	Rice	Gated	ungated	Good	Good	FMIS	FMIS			ISP/ADB	yes	yes			mixed				
Suranga	Jhapa	Suranga	600	600		good	rice	Gated	ungated	Good	Good	FMIS	FMIS		1996										
Rani	Kailali	Karnali	4,000	4,000	2,000	Good	Paddy					FMIS	FMIS	old/farmer	Not yet rehabilitated										
Jamara	Kailali	Karnali	4,000	4,000	2,000	Good	Paddy					FMIS	FMIS		Not yet rehabilitated										
Kuleriya	Kailali	Karnali	4,000	4,000	2,000	Good	Paddy					FMIS	FMIS		Not yet rehabilitated										
Gurgi	Kailali		2,150	2,150		?							FMIS												
Pathraiya	Kailali	Patharaiya	2,000	2,000	1,200	good	Paddy	gated	gated	good	fair	AMIS	TO	1972	1984/2000	FUID/IMTP	yes	yes	yes	yes	Tharu				
Mohana	Kailali	Mohana	3,500	1,000	500	Fair	Paddy	gated		poor		AMIS	JM	1984	2002	IMTP/ADB	yes	some			Pahari				
Kutiya	Kailali	Khutiya	1,500	-			Abondaned due to shortage of water in the source by UNCDF							1984		UNCDF	abondaned								
Tedi	Kailali	Tedi	1,500	1,500	200	good	Paddy	Ungated		Fair			FMIS	2052											
Kateni nala	Kailali		1,200	1,200									FMIS												
Bhajani	Kailali		700	700	150								FMIS												
Pratappur	Kailali		650																						
Chaumala	Kailali	Sirganga	1,000																						
Khurkhuriya	Kailali	Chaumala	650	650	100								FMIS	2052											
Banikulo	Kailali	Bani khola	1,800										FMIS												
Mahakali Stage I	Kanchanpur	Mahakali	5,000	4,600	4,600	good	Paddy	gated	proportional	good	good	AMIS	JM	1975/HMG	1986	IDA	yes	yes	yes	yes	Pahari				

INVENTORY OF IRRIGATION PROJECTS

Name	District	River	Area			Water	Main	Type of control		Condition		Management		Date built			WUAs		WUA Federation		Social	Conflicts	Other uses	Related systems	
			Gross	Monsoon	Spring	Supply	Crops	Main	Tertiary	Main	Tertiary	originally	now	Initial	Rehab	Program	Exist	Active	Exist	Active				Irrigation	Other
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Mahakali Stage II	Kanchanpur	Mahakali	6,800	4,500	4,500	good	Paddy	Gated	proportional	Good	variable	AMIS	JM	1998		IDA	yes	yes	yes	yes	Pahari				
Maleriyana	Kanchanpur	Maleriya	600	600	200	good	Paddy	gated		fair		new	FMIS	1996		ILC/IDA									
Banganga	Kapilvastu	Banganga	6,200	6,200	1,000	good	Paddy	Gated	Gated	good		AMIS	JM	1962	984 and 199	CADP/IMTP	yes	some	yes	some	yadav	fishing in reservoir			
Marthi	Kapilvastu		800	800									FMIS												
Jamuar	Kapilvastu		600	600									FMIS												
Bhadehar	Kapilvastu	Jamuwar	900																						
Pathardehiya	Kapilvastu	Surahi	700																						
Jabahi Sakuniyatal	Kapilvastu	Jawai	700	600	100								FMIS												
Pachain	Mahottari	Pachain	575	500	125	good	Paddy	Under construction				FMIS	FMIS		ongoing	SISP/ADB	yes	yes			Mixed				
Pasijwa	Mahottari	Pasijawa	500	500	150	good	Paddy	Under construction				FMIS	FMIS		ongoing	SISP/ADB	yes	yes			Mixed				
Bighi	Mahottari	Bighi	1,000	1,000		fair	Paddy					FMIS	FMIS		1998	SISP/ADB	Yes								
Bhulke Muhan	Morang	Bhulke Muhan	736	700	300	good	Paddy	gated	ungated	Good		FMIS	FMIS		1999	SISP/ADB	yes	some			Brahmin/Chhetri		no	no	
Belbari	Morang	Betauna khola	573	550	250	good	Paddy	Gated	ungated	Good		FMIS	FMIS		1996	ISP/ADB	yes	moderate			Brahmin/Chhetri				
Letang	Morang	Chisang	515	450	250	good	Paddy	Gated	ungated	Good		FMIS	FMIS		1990	ISP/ADB	yes	active							
Madhumalla	Morang	Nussari	571	550	250	good	Paddy	Gated	ungated	Good		FMIS	FMIS		1990	ISP/ADB	yes	active							
Sunsari Morang - stage 1	Morang, Sunsari	Koshi	9,750	9,750	7,000	Good	Rice	Gated	ungated	Good	Good	AMIS	AMIS/JM	1975/DOI	1990	IDA	yes	some	yes	yes	Mehta,Tharu				
Sunsari Morang - stage 2	Morang, Sunsari	Koshi	16,000	16,650	12,000	Good	Rice	Gated	ungated	Good	Good	AMIS	AMIS/JM	1975/DOI	1994	IDA	yes	some	yes	yes	Mehta,Tharu				
Sunsari Morang - stage 3	Morang, Sunsari	Koshi	13,000	13,000		Good	Rice	Gated	ungated	Good	Good	AMIS	AMIS/JM	1975/DOI	Ongoing	IDA	yes	some	yes	yes	Mehta,Tharu				
West Gandak (Nepal Canal)	Nawalparasi	Narayani	8,700	8,700	5,200	fair	Rice, sugar	Gated	Gated	fair	Poor	AMIS	FMIS	1975/India	1996	IMTP/ADB	yes	yes	yes	yes	Yadav	Handed over to WUA			
West Gandak (UP Canal)	Nawalparasi	Narayani	1,600	1,600	1,000	fair	Rice, sugar	Gated	gated	fair	poor	AMIS	FMIS	1975/India	1996	IMTP/ADB	yes	yes	yes	yes	Yadav	Handed over to WUA			
Pusaha	Nawalparasi	Pushaha khola	600	600									FMIS												
Shankhdev	Nawalparasi	Kerunge	950																						
Narayani stage I	Parsa	Narayani	15,900	15,900	10,000	Poor	Paddy	Gated	Gated	Good	poor	AMIS	AMIS	ICM			no								
Narayani stage II	Parsa, Bara	Narayani	12,800	12,800	6,000	Poor																			
Narayani stage III	Bara/ Rautahat	Narayani	8,700	8,700	4,000	Poor																			
Jhaj	Rautahat	Jhaj	2,000	1,500	600	good	Paddy	Gated	ungated	good	poor	AMIS	AMIS	1962-65		ICM	no	no			Yadav				
Chattis / Sorha Mauja	Rupandehi	Tinau	5,000	5,000	2,000	fair	Paddy	ungated	ungated	fair	fair	FMIS	FMIS	old/farmer - limited intervention			yes	yes	yes	yes	mixed				
Marchwar	Rupandehi	Tinau	2,950	2,900	1,180	good	Paddy	gated	gated	good	good	AMIS	JM	1995		UNCDF	yes	yes	yes	yes	Yadav				
Char Tapaha	Rupandehi	Dano	2,400	2,400		fair	Paddy	ungated	ungated	fair	fair	FMIS	FMIS	old/farmer - no intervention											
Ghagra	Rupandehi	Ghagra	2,000	1,000	100	poor	Paddy	Gated	ungated	poor		FMIS	FMIS	d/abandon	1998		yes	some			mixed				
Eghara mauja	Rupandehi	Siyari	1,500	1,500	400	fair	Paddy	ungated				FMIS	FMIS	old/farmer	1980+1998 (minor HW only)										
Motipur Khadwa	Rupandehi	Khadwa khola	1,400	1,400	500	good	Paddy	Gated		good		FMIS	FMIS		1996	ILC/IDA	yes	some			mixed				
Danda	Rupandehi	Danda	850	850	175								FMIS												
Amuwa	Rupandehi	Siyari	800			good	Paddy	ungated				FMIS	FMIS	old/farmer - no intervention											
Tenuhawa	Rupandehi		800	800									FMIS												
Parauha	Rupandehi		500	500									FMIS												no
Koshi Pump	Saptari	Koshi	13,180	7,000	5,000	Fair	Paddy	Gated	Gated	Good	poor	AMIS	AMIS	1977-90		India	No				Yadav				
W Koshi	Saptari	Koshi	11,300	7,000	5,000	Fair	Paddy	Gated	Gated	Good	poor	AMIS	AMIS	1977-90		India	No				Yadav				
Chandra	Saptari	Trijuga	10,500	10,500	4,000	Good	Paddy	Gated	Gated	Good	Good	AMIS	JM	1984 BS	Ongoing	IMTP/ADB	Yes	Yes	yes	yes	Mixed	no	no	In Udayapur	
Sundari	Saptari	Sudari	1,200	800	300	fair	Paddy	Gated	no	fair	good	FMIS	FMIS	2051		ISP/ADB	yes	yes			mixed				
Mahuli	Saptari	Mahuli	1,050	800	200	poor	Paddy	Gated	no	Poor	poor	FMIS	FMIS	2051		ISP/ADB	Yes				Chaudhari				
Khado	Saptari	Khando	600	600	300	poor	the system is not functional						FMIS	2051		ISP/ADB									
Manusmara (I)	Sarlahi	Manusmara	2,000	2,000	1,000	good	Paddy	gated	Gated	good	good	AMIS	JM	1958	984/ongoin	DP/ADB, IM	yes	yes	yes	yes	Mixed				
Manusmara (II)	Sarlahi	Manusmara	3,200	3,200	1,500	good	Paddy	Gated		Good			AMIS		1993	SISP/ADB	yes	yes			mixed				
Parsa	Sarlahi	Sapaha	685	650	250	good	Paddy	Gated	ungated	Good		FMIS	FMIS		1998	SISP/ADB	yes	yes			mixed				
Pattharkot	Sarlahi	Lakhandehi	625	600	100	fair	Paddy	Gated	ungated	Good		FMIS	FMIS		2000	SISP/ADB	yes	yes			mixed				
Sudama	Sarlahi	Manusmara	1,631	NA	NA	good	Paddy	Gated		Good			FMIS			SISP/ADB	yes	fair			Mixed				
Bagmati	Sarlahi, Rautahat	Bagmati	37,000	15,000	7,000	fair	paddy	gated	gated				JM	Under construction											
Gagan Nadi	Siraha	Gagannadi	1,200	1,200									FMIS												
Baburam khola	Siraha	Baburam khola	1,000	1,000		satisfactory	paddy	gated		good		FMIS	FMIS	1998		ISP/ADB	yes	yes			mixed				
Sahaja	Siraha	Sahaja	743	650		fair	paddy	gated		good		New	FMIS	1998/DOI	-	SISP/ADB	yes	yes			Yadav				
Jhirahari	Siraha	Jhirahari	554	550	200	poor	Paddy	Gated		poor		FMIS	FMIS	1999/DOI	1999	SISP/ADB	yes	yes			mixed				
Kamala Uttarayani	Siraha	Kamala	540	540	140	good	Paddy	Gated		good		FMIS	FMIS	1994		ISP/ADB	yes	yes			mixed				
Chanda Mohana	Sunsari	Katle and Budh	1,800	1,800	1,000	Excellent	Paddy	Gated	ungated	Good	Good	AMIS	AMIS/JM	1975/DOI	2001	OPEC/HMG	yes	Active	yes	Active	Yadav	no	no	no	
Haripur	Sunsari	Koshi seepage	600	600	300	Excellent	Paddy	Gated	ungated	Good		FMIS	FMIS		1993	ISP/ADB	yes	yes			mixed				
Tengra	Sunsari	Tengra	500	500	350	good	Paddy	Gated	ungated	Good		FMIS	FMIS		1993	ISP/ADB	yes	yes			Mehta,Tharu				

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Name	District	River	Area			Water	Main	Type of control		Condition		Management		Date built			WUAs		WUA Federation		Social	Conflicts	Other uses	Related systems	
			Gross	Monsoon	Spring	Supply	Crops	Main	Tertiary	Main	Tertiary	originally	now	Initial	Rehab	Program	Exist	Active	Exist	Active				Irrigation	Other
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
hills greater than 250 ha																									
Mahadev khola	Bhaktapur	Mahadev khola	450	400	200	Good	Paddy	gated		good		AMIS	FMIS	Old	1997	SISP/ADB	Yes	yes			Mixed				
Hinkhuwa khola	Bhojpur		260	110		Poor	Rice/maize	ungated	ungated	fair	fair	FMIS	FMIS	ngoing/DOI		SISP/ADB	Yes				Rai				
Gitachaur	Dailekh		435	Under construction												NISP/IDA	Yes								
Sewa Asewa	Ilam		317			Fair	Paddy			poor		FMIS	FMIS		1996	ISP/ADB	Yes	Yes			Mixed				
Kali khola	Ilam	Kali khola	800	800	400	Good	Paddy	gated																	
Kamal khola	Ilam	Kamal khola	250			Satisfactory	Paddy			Fair		FMIS	FMIS		1997	SISP/ADB	Yes	Yes			Mixed		Hydropower		
Ratuwa khola	Ilam	Ratuwa khola	400			Good	Paddy	gated		Fair		FMIS	FMIS	1998/DOI	new	SISP/ADB	Yes	Yes			Mixed				
Begnas	Kaski	Begnas Lake	580	580	200	Good	Paddy	gated	Variable	Good	poor	AMIS	AMIS	1990		Ist hill/ADB	Yes	some	nder process		Brahmin/ Chhetri				
Bijaypur	Kaski	Bijayapur Khola	1,280	1,200	800	Excellent	Paddy	gated	Variable	Good	poor	AMIS	AMIS	1966/ICM	1990	Ist hill/ADB	Yes		under process		Brahmin/ Chhetri				
Seti	Kaski	Seti river	1,030	1,030	300	Excellent	Paddy	gated	Variable	Good	poor	AMIS	AMIS	1985		China					Mixed				
Hyanja	Kaski	Yamdi	330	300	200	good	Paddy	gated		Good		AMIS	JM	1985		Ist hill/ADB	Yes	Yes			c				
Phewatal	Kaski	Phewa Lake	320	320	100	good	Paddy	gated		Good		AMIS	AMIS	1948	1959-63	ICM	Yes	fair			Mixed				
Khokana	Lalitpur	Nakku khola	250	250	100	good	Paddy	gated		Good		FMIS	FMIS	Old FMIS	1997	SISP/ADB	Yes	Yes							
Khodku	Lalitpur	Kodku	360	275	140																				
Tika Bhairab	Lalitpur	Lele and Naldu	700	400	200	Good	Paddy	gated		fair		AMIS	FMIS	Old		Rana regime	Yes	some			Newar				
Lubhu	Lalitpur	Lubhu khola	460	460																					
Rainastar	Lamjung	Chepe Khola	850	850	250	Good	Paddy	gated		Good		new	FMIS	1994		ILO, ILC	Yes	yes			Brahmin/ Chhetri				
Battar	Nuwakot	Trisuli	424	424	-	Good	disfunct system		Lift irrigation developed HMG in 1973-75																
Labdu Dhikure	Nuwakot	Tadi	360	360	300	Excellent	Paddy								1996						Fishing in lake, recreation, tourism				
Simara	Nuwakot	Tadi	400	400	250	Excellent	Paddy																		
Kachalphant	Palpa		282	282	-																				
Rampurphant	Palpa	Nisdi	760	650	600	Good	Paddy	Gated		Good	Good	AMIS	JM	2046		Ist hill/ADB	Yes	yes			Pahari				
Chamri nadi	Palpa		400	400																					
Phalebas	Parbat	Lamage	325	325	75	Good	Paddy	Gated		Good	Good	AMIS	JM	2046		Ist hill/ADB	Yes	yes							
Dharmawati	Pyuthan	Jhimruk	340	340	250	Good	Paddy	gated		Good	Good	FMIS	FMIS	1986		USAID	Yes				Brahmin				
Chaurjahari	Rukum	Jahari khola	600	600	450	Good	Paddy	gated		Fair		AMIS	FMIS	1976		HMG	Yes	yes							
Machami	Rukum		302																						
Jhutra Tupewa	Sankhuwa Sabha		300	250	100	Good	Rice	Gated		Good	Good	FMIS	FMIS	ngoing/DOI		SISP/ADB	Yes	Yes			Rai				
Salkot	Surkhet	Kamre and Bya	500	500	200	Good	Paddy	gated		Fair		FMIS	FMIS	1993		ILC/IDA	Yes								
Maintada	Surkhet	Goche khola	334			Good	Paddy	gated				FMIS	FMIS	1986	1998	NISP/IDA	Yes		No		Chetri				
Mehelkuna	Surkhet	Goche khola	300			Good		gated				FMIS	FMIS	1993		ILC/IDA	Yes								
Surkhet Valley	Surkhet	Chingad	2,900	Under consideration (Study)																					
Chapakottar	Syangja	Jyagdi khola	1,200	900	900	Good	Paddy	Gated		Good	Good	AMIS	JM	2030	1995	ILC	Yes	yes	Yes	yes	rahmin/ Chhetri				
Attrauliputar	Tanahun		450	450	300	Good	Paddy	Gated		Good	Good	AMIS	FMIS												
Chyanmengmaya	Taplejung		412	150		poor	rice	ungated	ungated	fair	fair	FMIS	FMIS	2000		SISP/ADB	Yes	Yes			Limbu				
Upper Baruwa	Udaipur	Baruwa	264	260	200	Good	Rice	Gated																	