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**WORKING PAPER 138**

# Synthesis of IWMI Work in Nepal

Dhruba Pant and Madar Samad



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International  
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**IWMI Working Paper 138**

**Synthesis of IWMI Work in Nepal**

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## Acronyms and Abbreviations

ADB	Asian Development Bank
AMIS	Agency-Managed Irrigation Systems
BIS	Banganga Irrigation System
CGIAR	Consultative Group on International Agricultural Research
DDC	District Development Committee
DoI	Department of Irrigation
FMIS	Farmer-Managed Irrigation Systems
GoN	Government of Nepal
HMGN	His Majesty's Government of Nepal
IAAS	Institute of Agriculture and Animal Science
IIMI	International Irrigation Management Institute
IMT	Irrigation Management Transfer
IMTP	Irrigation Management Transfer Project
INGO	International Non-Governmental Organization
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
LSGA	Local Self-Governance Act
MOU	Memorandum of Understanding
MWSP	Melamchi Water Supply Project
NGO	Non-governmental Organization
O&M	Operation and Maintenance
PIM	Participatory Irrigation Management
RTDB	Research and Technology Development Branch
USAID	United States Agency for International Development
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat
WGIS	West Gandak Irrigation System
WUA	Water Users' Association



## **Executive Summary**

The International Water Management Institute (IWMI), the then International Irrigation Management Institute (IIMI), began its activities in Nepal in 1986 under a Memorandum of Understanding (MOU) with His Majesty's Government of Nepal (HMGN), now the Government of Nepal (GoN). The primary objective of this was to undertake research in irrigation management and strengthen the research capability of concerned government agencies. Research on Farmer-Managed Irrigation Systems (FMIS) helped to develop appropriate mechanisms for providing support to enhance their performance. The research highlighted the importance of the users' role in irrigation management, which paved the way for initiation of participatory irrigation management (PIM) in Agency-Managed Irrigation Systems (AMIS). The formation of Water User's Associations (WUA) and the inclusion of women in it, introduction of the irrigation service fee (ISF), and the increased role of users in operation and maintenance were the major policy reforms that were introduced.

The studies in groundwater aimed at policy reforms by exploring the possibilities of introducing community managed electricity distribution to increase smallholders' access to groundwater irrigation through electrically operated small pumps. The river basin studies helped to facilitate formulation of a Water Resources Strategy of the GoN for integrated planning and management of water resources at basin scale, with appropriate institutional mechanisms and suggesting processes for its formation through follow-up action research.

The development of appropriate tools for studies on irrigation management, river basin, gender, institutions, and guidelines for research on FMIS and AMIS were the methodological contribution of the collaborative research. The involvement of local researchers gave them an opportunity to enhance their research skills and help strengthen the institutional capabilities of the agencies concerned.



## **INTRODUCTION**

HMGN, now the GoN, established a Water and Energy Commission Secretariat (WECS) in 1981 with a mandate to provide policy advice to the government on water and energy development. In 1985, the Ford Foundation (FF) provided grant assistance to WECS for the establishment of a planning and research unit in the WECS. It also allocated funds for research to IIMI, now IWMI, to provide technical support to WECS. In January 1986, WECS and IIMI signed a MOU. The objective of the IIMI-Nepal (Pradhan Forthcoming) program at that time was to:

- Promote and strengthen irrigation research capability in Nepal, and
- Undertake research activities in FMIS in Nepal.

IWMI has the mandate to work in cooperation with scientific departments, government agencies, NGOs and universities of Nepal, in accordance with the strategies, policies and priorities of IWMI and the GoN. In 1989, IWMI signed a MOU with the Department of Irrigation (DoI), with the objective “to strengthen the efficient and effective utilization of the already developed irrigation and water resources potential in Nepal” (MOU 1994). IWMI activity in Nepal is directed by the Consultative Committee, chaired by the Director General (DG) of the DoI.

In retrospect, IWMI’s research activities in Nepal can be grouped into the following categories:

- Irrigation Management Transfer (IMT)
- Water management in river basins
- Smallholder irrigation
- Groundwater management
- Gender and irrigation

## **IRRIGATION MANAGEMENT TRANSFER**

### **Farmer-Managed Irrigation Systems (FMIS)**

The first collaborative research (1986-1989) was carried out in the Indrawati Basin in the east of Kathmandu Valley. The action research enabled the development of both ‘physical’ and ‘social’ capital of the irrigation system and prepared for government support to the FMIS in Nepal, which, until then, were not receiving any kind of government support. The main activities carried out under this research agenda was the rapid assessment of FMIS to provide agency support, resource survey on availability of water and potential for expansion, farmer to farmer training (Rao and Abeywickrema 1992), physical structure improvement and promotion of PIM in FMIS (Pradhan Forthcoming). IIMI was also involved in evaluation of the process and performance of FMIS financed by the Agricultural Development Bank Nepal (ADB) through a package of technical know-how, finance and institutional arrangement for the development of irrigation systems for small farmers. During this time a major reorganization of the irrigation sector was taking place in Nepal through a merger of the Farm Irrigation and Water Utilization Division (FIWUD) of the Department of Agriculture (DoA) and small irrigation of less than 50 hectares (ha) of the then Ministry of Panchayat and Local Development to DoI, which was made the sole agency for the development of the irrigation sector.

## **Banganga Irrigation System**

In 1992, the GoN engaged in the management transfer programs of agency managed irrigation systems in accordance with Nepal's Irrigation Policy. The policy was to transfer all irrigation systems that were irrigating up to 2,000 ha in the plains and 500 ha in the hills to farmers - or by giving joint management of these systems to the DoI and farmers - to make these systems more productive and sustainable. Understanding the intricacies of the management transfer and learning lessons for future interventions was important for the DoI.

IIMI received funding support from the United States Agency for International Development (USAID) to undertake performance improvement of 6,000 ha through PIM in the Banganga Irrigation System (BIS) in Western Nepal. IIMI's activities focused on the improvement of water distribution and organizing irrigation users for operation and maintenance at tertiary canals and field channels (IWMI 2000). Farmers were encouraged to form WUAs. The agency officials of the BIS prepared a water allocation and distribution schedule in consultation with WUAs. Farmers were also encouraged to collect a fee for Operation and Maintenance (O&M), which reduced the O&M cost to the DoI. The major achievement of the project was to initiate dialogue between the DoI and the farmer for management transfer, and to form a task force to prepare national guidelines on policy for participatory irrigation (IIMI 1992). IIMI was organizing the WUA for IMT in branch canals, which was encouraging but there was also concern that the DoI might not be able to sustain this work as it had to complete organization of the WUA for the entire system. Therefore, it was requested that IIMI work be continued for the entire system.

## **West Gandak Irrigation System**

The project manager of the BIS, who was transferred to the West Gandak Irrigation System (WGIS), introduced innovative ideas in farmer organization, water allocation and distribution, and operation and maintenance of the irrigation systems (Pradhan Forthcoming). IIMI also carried out action research on the management transfer of this System, which has a command area of 8,700 ha and is in the western part of Nepal. The management transfer study focused on assessment of agricultural productivity, documentation of management transfer - outlining the processes followed in the formation of WUAs, introduction of training of farmers on the development of rules and regulations for resource mobilization, record keeping and O&M. The farmers from West Gandak were brought to nearby FMIS to learn the share system in allocation and distribution of water and labor mobilization according to the shares which they could introduce later in their system (Mishra and Molden 1996).

The Farmers' condition to support the turnover was the availability of water and the tailenders were in front to demand for turnover, as they expected easy access to water after IMT. Conflict resolution was one of the main activities of the committee. The study concluded that, in general, agricultural productivity has increased (Samad et al. 1999; Mishra and Molden 1996) in sites where IMT was introduced, which is due to rehabilitation and improved management brought about by IMT. However, it was difficult to attribute all these gains to IMT as other factors such as climatic variations may have also contributed. Another important observation made by the farmers' representative was on the farmers' resource mobilization, which was encouraging compared to the previous situation, where resource contribution was not tied to service delivery (Yadav 1998). In one of the transferred irrigation systems, the majority of farmers claimed that management has improved and felt that it made it easier to get assistance from the WUAs in transferred units as compared to getting the assistance from the agency in non-transferred units (Samad et al. 1999).

An interesting observation made during study on ISF (Sijapati and Prasad 1998) was the lack of legal backup for collection and spending of the resources by farmers, which was identified as a major constraint. The study also found that the collection was far below the required amount for O&M, although the contribution from the government towards maintenance had decreased; The study concluded that this could affect the sustainability of agricultural production in the long-run due to underinvestment; and warned that this situation may lead to the cycle of rehabilitation-decline-rehabilitation and will not be helpful in reducing government expenditure in the long-run. This was substantiated later by IWMI field observations in the WGIS, which was in a deteriorating state due to weak management and awaiting rehabilitation. The lessons learned from the study, which are still valid, suggest that there is a need to identify an alternative mode of IMT taking into account the failures in the past that had to be overcome to achieve the desired result, especially in the case of ISF and O&M for operation of the irrigation systems in future.

IIMI was intensively involved in documenting the management transfer processes in the Banganga and West Gandak irrigation systems. The Institute, in partnership with the Research and Technology Development Branch (RTDB) of DoI, was also involved in organizing studies in other irrigation systems to understand the various aspects of the IMTP. The study findings from the IMT project, in general, is presented in the following paragraphs.

The documentation of the rehabilitation process, institutional development process and post-transfer support was also carried out under the IMT project. The aim of this was to get a clearer picture of irrigation management practices and WUA dynamics at local level. The study was carried out in collaboration with the Institute of Agriculture and Animal Science (IAAS), Rampur Campus, through their students who stayed at villages for extended periods during three years and carried out documentation in great detail on WUA meetings, elections, decision-making patterns and organization of canal maintenance (Shukla et al. 1998). The study pointed out the high degree of local party politics involved during the election process of WUAs and IMT. This was especially the case where there was absence of strong leadership in the community. This had adverse effects on the smooth functioning of the WUA, and later on it was found that in one scheme the WUA almost became defunct because of political intolerance among functionaries and representatives in the WUA.

Rehabilitation processes indicated that the strategies, scope of work, cost sharing and implementation of rehabilitation vary greatly from project to project and also the outcome. Generally, it was assumed that the accountability of contractors to the WUA, joint inspection of the work by government officials and farmers, and completion of work to their satisfaction would ensure greater chances of success. However, the reality was more complex. For example, management turnover of West Gandak, Khageri and Panchakanya were initiated at the same time. Khageri and Panchakanya with a command area of 3,900 and 600 ha in the central part of the country followed the same elaborate procedures based on the assumptions mentioned above. Still, results measured in terms of farmer satisfaction and WUA effectiveness was very different (ibid). It was found that strong leadership of one person in Panchakanya resulted in a well-functioning WUA, while the absence of such leadership in West Gandak resulted in a high interference by local politics and personal gains in awarding contracts in rehabilitation works. Thus, it was evident that strong leadership was more important than the rehabilitation process and creating an environment for the emergence of strong leadership was challenging for the success of rehabilitation. The differences in the success of IMT could also be attributed to the size of the irrigation schemes. In comparison, the WGIS is much larger than the Khageri and Panchakanya irrigation systems.

The study on institutional development processes (Upadhyaya 1999) observed that the effectiveness of WUAs in carrying out irrigation management tasks varied across the irrigation

systems, which pointed to the scope of improvement in areas of O&M, ISF collection, empowerment and governance. But it concluded that the functional status of WUAs is reasonable to good in systems where institutional development processes preceded the management transfer compared to systems where rehabilitation and institutional development were taken together. In essence, management transfers to an effective WUA will result in better performance of the transferred irrigation schemes.

The research study identified areas for post-transfer support by analyzing the performance of various WUAs which have just begun to manage irrigation systems; found a great variability in the effectiveness of WUAs; and made suggestions for building-up the institutional capacity of WUAs through a responsive need-based approach. Another important area the study identified for support was in agricultural extension; financial services and technical engineering services. It also suggested that revisions be made on policy and regulations for the effective functioning of WUAs. Two important policy recommendations were made:

- The agency should identify specific and measurable indicators of IMT to enable its evaluation later on, which was not very clear when it was implemented; and
- The government should provide adequate resources and WUAs should also strive to collect fees from farmers to strengthen the institutional capabilities of WUAs.

The research on IMT in Nepal was also part of IIMI's ongoing program to assess the impacts of IMT in various countries of the world at that time. A comparative analysis of management transfer in six countries including Nepal (Frederiksen and Vissia 1998) indicated that comprehensive legislative provisions need to be enacted before service transfer. The study also emphasized the role of local beneficiaries and local entities besides the Central Government, especially for O&M, as only the government can play the role of regulator for providing water services. The comparative study was valuable in providing policy recommendations on the roles that entities could play at various levels — from central to the local level — and also suggested guidelines for management transfer. It also suggested various aspects for consideration in management transfer such as drainage, water rights, and future availability of water for irrigation and other uses (ibid).

IIMI's assessment of IMTP in Nepal concluded that government expenditure on IMTP reduced government budget transfer for O&M. However, in the WGIS, irrigation cash cost to the farmer was found to be higher in the tertiary canal transferred to the farmers than that of the canal not transferred to the farmers. But water allocation and distribution was much fairer in IMT schemes compared to before (Samad 2002). In the case of groundwater, the pumping charges in IMT schemes were higher than that of non-IMT schemes.

One study in irrigation management focusing on public-private partnerships and equity issue was carried out by IWMI in the Andhikhola Irrigation and Hydel project. The study looked at the processes by which the land redistribution to the landless and marginal farmers was made, and whether it was 'pro-poor' and addressed social equity as envisaged or not. The study observed that the land and water distribution to the poor was a positive step towards achieving social equity. However, the benefit to the poor could have been enhanced had it been effectively implemented. The lack of representation of the poor in the planning and decision-making committees for land and water distribution was identified as the main reason for this situation (van Etten et al. 2002).

## **WATER MANAGEMENT IN RIVER BASINS**

### **Indrawati River Basin**

The study funded by FF was carried out in collaboration with the Water and Energy Commission Secretariat (WECS) in the Indrawati River Basin from 1999 to 2002. At this time, the government was in the process of preparing a Water Resources Strategy and needed field level information on integrated water resources management (IWRM). Therefore, the main objective of this study was 'to generate key information and recommendations for integrated water resource development and management strategies that combine the objectives of productivity, equity and resource conservation' (IWMI 2001).

This study was exploratory in nature. The selection of this basin was done in consultation with the WECS. The selection of the basin was also appropriate for the study, as a major water transfer project – the Melamchi Water Supply Project (MWSP) - to Kathmandu Valley was being implemented by the GoN. Therefore, the study could also assess the likely implications of water transfers on other water uses in the basin.

The study focused on assessment of the resource base; water accounting; process documentation of Melamchi Water Supply Project; inclusion and exclusion process; and formal and informal institutional arrangements (Bhattarai et al. 2002). All the studies were jointly carried out by IWMI researchers, engineers from WECS and the DoI. A steering committee chaired by the secretary of the WECS was formed to guide the study. The studies made some important observations in the following areas:

#### ***Water Accounting***

Water accounting is a procedure followed to account for the use and productivity of water resources, based on a water balance approach. It classifies outflows from a water balance domain (basin/irrigation project/irrigation field) into various categories, to provide information on the quantity of water depleted by various uses (Molden and Sakthivadivel 1999). From the water accounting result, it has been observed that the basin on the whole is open, whereas the subbasin and its tributaries may be closed or closing. The study indicated the potential of increasing water productivity and also cautioned that further withdrawals of water may have other adverse effects on the social and environmental fronts in the long run. The study was skeptical of the MWSP for not taking into account agriculture and other uses, while proposing for maintaining a minimum flow of 0.4 cubic meters (m<sup>3</sup>) of water for aquatic life (Mishra and Shilpakar 2001).

#### ***Institutions***

The study observed that strict rules and formal organization for water allocation had not been developed yet due to sufficient water availability and the customary practices, which governs the allocation norms. Therefore, the conflict among water users was less pronounced. The customary practices guaranteed the right of the users, where irrigation received first priority over other uses.

However, competition for the use of water has been increasing in recent times due to the development of electricity and irrigation projects including the MWSP. The growing competition among various sectors may create more stress on the present institutional mechanisms for allocation

and conflict resolution. This could facilitate the emergence of formal institutional arrangements to buffer the shocks brought on by new projects.

The study found that the Village Development Committees (VDCs) and District Development Committees (DDCs) were contributing to the development of electricity projects. It was observed that the DDC was seeking a bigger role in water resources development, which it thought was still inadequate considering its role in other development sectors in the district (Pant 2001).

### ***Melamchi Process Documentation Research (MPDR)***

The process documentation research of MWSP indicated that there was minimal involvement of the local communities in the decision-making process of the project and they were less informed of the impacts of the Inter-Basin Water Transfer (IBWT). They were skeptical of the water availability for various activities after the planned diversion of water to Kathmandu Valley. This was also largely due to inadequate interaction between project officials and local stakeholders, and inadequate sharing of information by officials of the MWSP (Devkota 2001).

### ***Inclusion and Exclusion***

The study showed that new water-related projects were being implemented in the basin utilizing the same source of water, and rights of the prior appropriators are encroached without giving them any form of compensation. In particular, this is already problematic in the case of Ghatta<sup>1</sup> owners and mill owners. Lack of established rules and regulations for water allocation, distribution, and O&M, especially during the lean season (March-June), was the major reason for this.

One of the important observations made was the compulsory contribution of cash or labor during the development of new water projects, which was detrimental for the exclusion of poor and marginal households who do not have the resources (cash) to contribute. In most of the cases, village leaders and the rich people did benefit from new water projects, as they initiated the project because of their good linkages with the government officials. The poor and socially deprived farmers were excluded because their interest was not sufficiently represented in decision-making processes (Upadhyaya 2001), their inclusion in irrigation projects has reduced poverty in participating households and had also secured water rights for the future generation.

### **East Rapti River Basin**

Another important basin level water management study was carried out from 2000 to 2002 - with funding from the Asian Development Bank (ADB) - in the East Rapti River Basin in the central region (IWMI 2003a). This was part of a regional study in five (China, Indonesia, Sri Lanka, Philippines and Nepal) countries with an objective of:

‘Understanding various facets of basin level water management practices and providing recommendation on policies and institutional innovations to increase productivity through improved basin management’ (Molden 2000).

This was a participatory action research emphasizing on the stakeholder consultation processes. The socioeconomic, water accounting and institutional analysis were the main components of the

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<sup>1</sup>Traditional water mill used for grinding maize.

study. The purpose of the study was to also prepare the action plan for the basin. However, it could not happen due to a low level of participation from the stakeholders (Bandaragoda 2005).

### ***Water Accounting***

The major findings of the study showed that the East Rapti River Basin was an open basin, and agriculture was the main user with seasonal and temporal variations in water availability across the basin. This led to competition between water uses, which was contributing to inter-sectoral conflicts (irrigation users and the Chitwan National Park; irrigation users and industrial establishments; and the Park and fishermen) due to increasing water demands. This was attributed largely to the lack of clear-cut policies on securing water use rights, water licensing and pricing, surface water and groundwater use, and water quality regulations, which are guided by sectoral policies of various ministries. This was a barrier for a holistic approach which was necessary for the emergence of institution for IWRM.

### ***Institutions***

Findings of the study observed that legislations were not sufficient for facilitating the creation of new basin level institutions, and regulatory framework were required for water allocation and sharing, participation of private sector, on water rights, pollution control and environment management, water pricing and cost recovery, and groundwater. Therefore, water users were following both customary practices and legal provisions as specified in the Water Resources Act (WRA) of 1992, but the provisions of the Water Resources Regulations of 1993 — for formation of users' organizations, district water resources committees, licensing for the use of water resources, and committees for resolution of disputes - are not enforced or implemented properly at the local level.

Another issue of major concern was the lack of harmony between the related laws (Water Resources Act, 1992; Drinking Water Regulation, 2055 (1999); Irrigation Regulation, 2056 (2000); and Local Self-Government Act (LSGA), 2055 (1999), which dealt with comprehensive legislation on water resources development, utilization and conservation. These laws have prescribed a set of separate and contradictory procedures with regard to licensing, constitution of users' groups, dispute settlement mechanisms and a committee for fixing tariffs and show a certain amount of incongruity.

The study recommended that the preferable option would be the consolidation of the Water Resources Regulations of 1993, with all conflicting provisions found in various regulations relating to licensing fees, registration of WUAs, irrigation, drinking water service fees and dispute settlement mechanisms. While doing so, it is necessary to amend the Irrigation Regulation, 2056 (2000) so as to make District Water Resources Committees responsible for registration of WUAs. Likewise, the LSGA and Regulations need additional provisions under which DDCs, VDCs and municipalities are also required to get a license for proposed/planned drinking water and irrigation projects, leaving the service delivery and implementation functions to them.

The study concluded that although statutory laws have been promulgated and amended over the last 30 years, many of the activities related to water rights in the water sector are still based on customary rights. As Nepal's population grows, water stresses will be felt frequently and conflicts on water use will also be more frequent. Since water resources development is an integral part of the national economic growth strategy, there will be new investments in infrastructure that will require trade-offs and/or compensation to existing users. This means that the legal framework for

water use in Nepal must address these emerging issues and it must be able to facilitate a transition from customary rights to statutory rights (Bandaragoda 2005). In addition to the legal framework, there must be an improvement in the enforcement of statutory laws and regulations.

### *Assessment of Environment Flows*

The development of a hydrology-based methodology for environmental water allocations (Smakhtin and Shilpakar 2005) was the first study of its kind in Nepal, which aimed to bring attention to the need of considering environmental flow requirements in national water planning. The study developed a new method to estimate such requirements, using the readily available hydrological daily time series data. It also suggested a simple technique by which hydrological data for environmental flow assessments can be generated for ungauged sites. The East Rapti River was selected for the study because of its high conservational importance (e.g., Chitwan National Park). The follow-up study (Smakhtin et al. 2006) also tested other simple methods of environmental flow assessment in the East Rapti River Basin. These studies advocated the preemptive approach for conservation of aquatic environment in Nepal, i.e., setting environmental thresholds for use of river water before the major development started in a basin.

### *Other Studies*

The study carried out in collaboration with IAAS on the effects of small-scale irrigation to improve household level food production in the buffer zone indicated that small-scale irrigation played an important role for the food security of the household and the investment in it needed to continue (Adhikari and Pant 2003). The action research on dialogue on water and food among concerned stakeholders in the East Rapti River Basin helped facilitate the interaction among users and other stakeholders for better management of water and other natural resources in the basin.

IWMI and the National Agricultural Research Council, Nepal, has conducted soil erosion management action research in one of the watersheds in the central region of the country. The purpose of this study was to look at the on-site effects of erosion and its potential off-site impacts in relation to erosion and land use, and erosion and catchment size (Maglinao and Leslie 2001). The first phase of the study was successful. However, Nepal was not included in the latter phase of the study. Thus, testing and further improvement of the technology could not be carried out.

### **Begnas Basin**

IWMI, in collaboration with national and international partners, conducted action research entitled 'Resource Management for Sustainable Livelihood' in the Begnas Basin in West Nepal and Hillaugad of Uttaranchal in India from March 2003 to September 2008, with funding from the Challenge Program on Water and Food (CPWF) of the Consultative Group on International Agricultural Research (CGIAR). The objective of the study was:

“To contribute to the livelihood enhancement of natural resource users by scaling up water and forest management practices in an integrated way based on the better understanding of existing community-based strategies” (IWMI 2003b).

The focus was to identify mechanisms for the evolvement of institutions for Integrated Natural Resource Management (INRM) at basin level. This was a participatory action research, in which the

stakeholders at community, district and national level participated at various stages of the research. The major findings of the study are presented below.

### ***Legal, Policy and Institutional Review***

One of the important activities of the research was to understand congruence and divergence in the legal, policy and institutional provisions for the integrated management of resources at the catchment level. The review found that the provisions do not take into account the holistic approach in resource management and suggested that various reforms be included in them with focus on water, forest and local governance issues. This study also pointed towards the lack of harmony in the existing laws and reinforced the findings of the institutional study carried out in the East Rapti River Basin. This was indicative of the slow reform process and the reluctance of the government to incorporate necessary changes in the existing provisions suggested by previous studies. The study pointed out that INRM is the coordination and complementarity in government policy, legal and institutional provisions, and among the agencies involved in resource management from the central to the local level (Pant 2009). The study suggested that existing interrelations and dependencies among them at various levels need to be recognized.

### ***Assessment of Resource Base***

The assessment of the resource base in the study area was important in knowing the availability, access and use of resources. There was a wide gap between the upstream and downstream users with respect to access to resources. The access to productive resources was constrained for upstream users due to the limited agricultural land and underdeveloped traditional irrigation systems. The important resource for upstream users was the community managed forest, but they have not been able to derive optimum benefits from it due to lack of its economic value. However, this has contributed to the availability of water downstream where fishers and irrigation user groups are deriving benefit. The existing inequality in benefit sharing from natural resources among the upstream and downstream users was identified as one of the major constraints in INRM (Parajuli and Sharma 2009).

### ***Platform Formation***

Keeping in mind the findings from the field study and the outcome of the consultation with the stakeholders at various levels, the project facilitated the formation of a 'Platform' of the stakeholders.

“Platform is a venue where resource users and stakeholders are brought together to discuss the issues related to resource management and it is believed that this process will contribute to the users and other stakeholders’ understanding and thinking on integrated resource management” (Pant and Shrestha 2009).

‘Platform’ was formed to facilitate the integrated management of natural resources at sub-basin/catchment level, as envisaged in the Water Resources Strategy (2002). Interactions between the platform officials and the concerned officials to share the outcome of the action research were organized at local, district and central level along with the formation of the platform.

## **SMALLHOLDER IRRIGATION**

A study on poverty-focused smallholder water management practices was carried out in Nepal in 2001 with funding from the UK Department for International Development (DFID). The study focused on assessing the field situation of the micro-irrigation technology — the drip irrigation in the hills of Nepal and its viability for expansion in future — implemented by the International Development Enterprises (IDE)/Nepal. The purpose of this study was:

“to create an elaborate knowledge base which will allow one to assess the success or otherwise of the drip irrigation innovation besides facilitating development of practical mechanisms for promoting the innovation in smallholders water management units for improving their livelihoods” (RITI Consultants 2001).

The study looked at the adoption of drip irrigation technology in the hills of Nepal and gathered farmers’ perception towards it through the household survey. The findings of the study were encouraging for the expansion of drip irrigation technology, as farmers have started deriving cash income from the production and sales of vegetables. However, it also pointed out that access to the market and the price of vegetables are the main constraints preventing farmers from adopting this technology (Kalu 2003).

By improving on the single-use drip irrigation technology, since 2003 IDE, Nepal, has been introducing Multiple Use Schemes (MUS), which also provided drinking water. Thus, the water supplied was for both domestic (household) and productive (irrigation) use. IWMI carried out a study of nine MUS schemes in 2004 with an objective:

“to assess the users’ perception on the adoption of multiple use scheme (MUS) technology and household benefit in terms of time saving and income” (IWMI 2003c).

The study documented that the users’ response, and also the benefit, varied across the system. These variations were due to the differences in types of technological interventions, price differences of vegetables and vegetable seed, market access, and availability of technical support (Pant et al. 2006). The study recommended that a catchment approach be used for the development of MUS. Also, the IWMI-led MUS project, funded by the CPWF, had documentation and promotion of MUS activities that were carried out in Nepal in partnership with IDE, Nepal.

## **GROUNDWATER MANAGEMENT**

The first study on groundwater was on the groundwater-energy nexus in 2002, which looked at the historical perspective of groundwater development in Nepal along with types of energy used in groundwater extraction. The study highlighted the importance of electricity for expansion of groundwater and drew attention towards the unavailability of electricity, which was the constraining factor for groundwater extraction and agricultural development in the Terai (southern plain area in Nepal). The study also pointed out that the diesel-operated pumps were not cost-effective for small and marginal farmers, and these were being used as insurance against the untimely rain. Therefore, the study recommended expansion of the rural electricity network and removal of the ‘minimum demand charge’ for electricity operated pumps to promote groundwater development (Joshi et al. 2002).

Under funding from the IWMI-TATA groundwater program, a survey on the socioeconomic and ecological implications of groundwater irrigation in the Terai of Nepal was carried out in 2003 to gain a broader understanding of its groundwater development status. Like the previous

study, this also concluded that installation of the shallow tubewell was beyond the reach of the small and marginal farmers (less than 0.5 ha of land) due to the high cost of diesel pumps and its fuel (Pant and Belbase 2003). Later on a study in the eastern part of the Terai of Nepal revealed that wherever there was access to electricity, farmers were encouraged to install small pumps and this increased their access to irrigation (Kansakar et al. 2009). Thus, the study recommended policy reform to facilitate the electricity extension in the Terai to increase small farmers' access to groundwater irrigation.

A comparative study of irrigation water costs in relation to the use of diesel in some states of India, Pakistan, Bangladesh and the Terai of Nepal showed that farmers in Nepal are in a disadvantageous position in using groundwater due to the increasing diesel costs. The farm gate price of rice is low in relation to the cost of the diesel used to produce it, and farmers are reluctant to use diesel pumps even though they are primarily used by all farmers in the Terai. The consequence of this is that there is a shrinking water market due to the rising cost of water (Shah et al. 2006).

The government policy of involving the community in the distribution of electricity for domestic use in the rural areas in Nepal has been successful in reducing the cost of distribution, collection of tariffs and controlling the non-technical losses. IWMI carried out a study to document the community based electricity management experiences to explore its application for the promotion of tubewell irrigation, as earlier studies had indicated that unavailability of electricity was the major constraint for expansion of groundwater development. The study concluded that the organization of users could be entrusted for the distribution of electricity in tubewell irrigated areas. The study made recommendations to promote users' participation in community managed electricity distribution in the Terai, tax exemption to users' cooperatives and explicit provisions for sharing of the distribution network between agriculture and industrial use to avoid conflict between them. These provisions will help groundwater expansion in the Terai and increase smallholders' access to groundwater irrigation and strengthen the community organization for electricity distribution. This study also identified that expansion of the electricity network in the rural areas as being the main constraint for expansion of tubewell irrigation (Shilpakar and Pant 2004).

A training-cum-research programme was organized under the Groundwater Governance Project funded by the CPWF. The primary focus of the study was to train mid-level managers on the theoretical and practical aspects of groundwater issues to equip them for policy level decision making at a later stage. Similarly, the training for high officials focused on providing them with knowledge on various aspects of groundwater management in developing and developed countries. Both junior and senior officials participated in the programme and benefited from it.

A scoping study of wastewater quality, treatment and its use in Kathmandu Valley was also carried out by a MSc intern from Colorado University to understand the wastewater practices in urban areas. The study found that wastewater use in all three municipalities in Kathmandu Valley, although on a small-scale, was mainly used for vegetable production (Rutkowski et al. 2007).

## **GENDER AND IRRIGATION**

IWMI research on the gender aspect of irrigation was pioneering at a time when the role of gender in irrigation management had not been explored and was poorly understood. An important study on the gender role in irrigation management was carried out in WGIS, where the researchers found that there was a need to increase women's role in decision-making processes (van Etten et al. 1999). The action research also took steps to encourage the participation of women at different levels of the WUA, and has increased the number of women in subcommittees of the WUA. It was

also observed that women irrigators, although significant in number, have to compete to irrigate their field with men and they were placed in a disadvantageous position (van Koppen et al. 2001; van Koppen 2001). The study suggested capacity building for women and increasing their role in decision-making through their representation in the WUA.

Later on IWMI also carried out a study on the gender role in smallholder irrigation. Women's involvement in smallholder irrigation was significant as the technology was simple, most of these irrigations were close to the households and suitable for small-scale vegetable farming. The study on drip irrigation (Upadhyaya et al. 2005) revealed that this has a positive impact on women, as the time used for fetching water has reduced due to the development of nearby water sources and has encouraged vegetable production. Consequently, there has been a positive impact on the household food and nutritional intake. Likewise, an assessment carried out by the IWMI-Nepal, on the implementation of Multiple Use Schemes (MUS) for IDE/Nepal (Pant et al. 2006), revealed that women were empowered due to their access to the cash income from vegetable farming, exposure to training and outside contact.

## **IMPACT OF IWMI'S WORK IN NEPAL**

From the discussion above on the types of projects, their focus and major findings, it is clear that each of the projects had some impact. Some of the projects were successful in contributing to policy reforms. However, some of the recommendations did not have the desired level of impact at policy level, as these were not mandatory for the agencies to implement. Nevertheless, given the thrust of the project, each of them had a major impact in one of the following areas.

- Policy contributions
- Methodology development and its application
- Institutional strengthening and capacity building

### **Policy Contributions**

The study on FMIS, IMTP and river basin studies had focused on helping agencies in the formulation, amendment and implementation of the policies. The contributions from these studies to government agencies were largely dependent on government policies at that time and uptake of the findings of the study. For example, the irrigation management and river basin studies had coincided with government policy changes. In most of the cases, the impact of studies carried out by IIMI was constrained by their duration, as rightly pointed out in the following paragraphs.

“IIMI research is on a ‘project’ mode for a period of three to five years and has to be discontinued at project implementation phase due to lack of donor funding. This was not helpful to look at the output and impact phase of the project. Therefore, the programme mode of operation would be useful to the project mode” (Rao and Abeywickrema 1992).

All the studies in Nepal were also carried out in the project mode. However, the policy implications are mixed from project to project. Generally, the research carried out was effective in influencing policy changes, but due to lack of follow-up support they were not very successful at implementation stage of the projects. The policy contributions of studies carried out by IWMI in Nepal are presented in the following paragraphs.

### *Irrigation Management Transfer*

IIMI's involvement in the beginning (in 1988) helped understand the dynamics of FMIS and created awareness of its importance to the government and donor officials. At that time, a major policy reform - from a project approach to sector approach - in irrigation and assistance to FMIS was being discussed. IWMI's collaborative research with national partners made policy contributions on developing mechanisms for assistance to FMIS; helped to develop a participatory approach in irrigation management; and improvement in O&M in public sector irrigation systems in Nepal. During this period, the study on large-scale FMIS in Western Nepal contributed towards making policymakers aware of the dynamics of the functioning of such schemes. The findings of the study were helpful in designing the WUA for Rajapur Irrigation System in West Nepal (funded by ADB, Manila) and other agency managed irrigation systems.

An assessment of the IIMI program in Nepal from 1986-1992 (Rao and Abeywickrema 1992) identified three major areas of contributions:

- Policy contribution to system turnover and participatory management
- Efforts at institution building and management development
- Strengthening national capacity for irrigation research

The assessment pointed out that studies on FMIS had influenced policymaking on the role of WUAs in the effective management of AMIS, which was not participatory.

Contribution to policy was also made by providing input in the development of Irrigation Master Plan (Yoder et al. 1988) and also being a member in the Task Force on the invitation of the government for the preparation of 7th Five Year Plan of Nepal. Likewise, IWMI was requested for its input on the draft Irrigation Regulation 2056 (2000) of Nepal. Suggestions were provided by a group of IWMI researchers and research findings, suggestions and recommendations from the IMTP study were reflected in the Irrigation Regulation 2056 (2000) in the following areas (Pradhan Forthcoming):

- The government's facilitating and supporting role for capacity building and strengthening of WUAs, fixing of ISF, its collection and investment, and joint performance monitoring for O&M after management transfer.
- The government's regulatory role for water quality control, environmental protection and security of water rights.

The IMTP project helped establish the IWMI-Nepal Consultative Committee, chaired by the Director General, DoI, with representation from an interdisciplinary group of people from various governmental and non-governmental organizations and universities. Later on this committee became permanent and is supposed to meet regularly every year to guide the IWMI-Nepal work.

Some of the policy recommendations on IMT were to make the main committee more responsible for the management of irrigation systems, sufficient mobilization of the cash and labor resources for O&M and enforcing the rules (Mishra and Molden 1996). The policy impact of these recommendations is, however, mixed as all these have not been implemented by the government. For example, government policies on the users' role on asset management (ibid) is still not clear, which was one of the recommendations of the study, as it was important to delineate the roles and responsibilities of users and the agency.

A policy level workshop on Management Transfer (MT) (Pant et al. 1992) was organized to look at the impact of the IMT project. There was some skepticism with regards to the sustaining of the irrigation system due to withdrawal of financial support given by the DoI and inadequate capacity of the WUA to raise the resources. The workshop also identified issues central to the participatory management as follows (ibid):

- Farmers' unawareness of policies, laws on water resources, and water rights are not explicitly recognized by DoI.
- Involvement of farmers and National Agricultural and Research Extension Systems (NARES) in research and data collection.
- Farmers' participation should also be during the planning and construction stages and not only after the construction.

The gender study in this project contributed to policy by making a certain percentage of women users' representation in the WUA mandatory in irrigation policy. This has helped to increase women's role in decision making of both FMIS and AMIS. This was a major policy reform which is being practiced till now.

The ISF study on government policies, institutions and irrigation financing modalities with focus on the farmers' ability to bear the irrigation financing vis-à-vis cost of production and the market price of the output (Small et al. 1986, 1989; Martin et al. 1989; Prasad et al. 1998) were important to the government in preparing guidelines and policies relating to cost recovery mechanisms. The impact, however, is not visible due to the government's inability to enforce the guidelines through appropriate policy interventions with adequate legal provisions due to the lack of political commitment.

### ***Water Management in River Basins***

The research in the Indrawati Basin was able to generate increased interest among the planners and decision makers on developing appropriate institutional mechanisms for the river basin, as the conceptual basis for river basin planning was evolving in Nepal at that time. Comments/suggestions were also provided by a group of IWMI researchers on the draft Water Resources Strategy. The research findings, suggestions, and recommendations of the study were reflected in the Water Resources Strategy, 2002, of GoN (GoN 2002), mainly in following areas:

- The River Basin is regarded as a unit for water resource planning and management of IWRM in Water Resource Strategy.
- The Water Resources Strategy has visualized formation of subbasin and basin committees for basin planning.

Likewise a policy workshop on IWRM in the River Basin was organized in Kathmandu, Nepal, in March 2001 (Kayastha et al. 2001), where the member of the Planning Commission, Executive Secretary and Director of WECS, higher officials from various ministries, NGOs, and consultants participated. The findings of the study were presented to the professionals and were appreciated by policymakers as timely for formulation of the Water Resource Strategy (Kayastha et al. 2001).

The policy contribution of the East Rapti River Basin study was the ministerial level workshop held in Bangkok comprising participants from five countries to exchange ideas and views on river basin management. This was jointly organized by IWMI and United Nations Economic and Social

Commission for Asia and the Pacific (ESCAP) at the conclusion of the five countries' institutional study (Bandaragoda 2005). The minister along with high level officials from Nepal participated in the workshop. Since, Nepal had just drafted the Water Resources Strategy with a focus on IWRM, the workshop was a learning experience for the delegates from Nepal on the experiences of other countries on water management at basin scale.

### ***Groundwater Management***

The studies on groundwater management were able to raise awareness on groundwater issues among the policymakers, but did not have a visible impact on government policies, as the government at present does not have a separate groundwater policy for the country. Also, most of the studies were of an exploratory nature with very limited objectives and lacking in-depth analysis to influence government policies. The expansion of these studies would be helpful for policymaking in the future, as the government is in process of formulating a separate groundwater policy. However, the training of high level officials on groundwater was helpful in strengthening their capacity through field research and exposure visits.

### **Methodology Development and Its Application**

#### ***Irrigation Management Transfer***

The first project – action research on FMIS was the first of its kind in the water sector in Nepal. Therefore, the methodology developed in this project was of great importance to the water sector in Nepal. The methodology development and its application in the following three areas from this project were important contributions to studies in the water sector (Pradhan Forthcoming).

- Development of Checklist for Rapid Appraisal of Irrigation
- The basis of cost calculation for administrative and rehabilitation costs
- Initiation of process documentation research

The Checklist for Rapid Appraisal for pre-feasibility study of irrigation systems was adopted by other consultants and donors such as Sir MacDonald and Partners Ltd., in association with MacDonald Agriculture Services Ltd., and East Consult. Likewise, two donor agencies, Netherlands Development Organisation (SNV) and International Labour Organization (ILO), adopted the same modalities for cost calculation in their irrigation projects in the Mechi and Dhaulagiri Zone, respectively. IIMI's work during this period also included studies for the donors which enabled them to look for alternative strategies for rehabilitation of FMIS. One such study was the Rapid Appraisal of FMIS in the Kailali District carried out for the World Bank (Pradhan Forthcoming).

IIMI's work on this project also provided a basis for development of the Nepal Irrigation Database by Indiana University in collaboration with IAAS (ibid). A seminar on field-to-farmer organized by IIMI and IAAS (Pradhan 1994) helped look into the issues of different methods of data collection, and IIMI encouraged collaboration with academics both within and outside Nepal which had a positive impact in enriching the knowledge base on FMIS.

The development and application of participatory rural appraisal (PRA) tools (Gosselink et al. 1995; Gosselink and Strosser 1995) in gaining a clear understanding of the role of irrigation on local livelihood strategies, by taking into account gender and other social characteristics, to analyze the relationship between the irrigation performance and livelihood from farmers' perspectives, was an important methodological contribution for the study of irrigation systems in Nepal. This is because the information from selected FMIS in three districts of Nepal was also included in the study. One of the weaknesses of the PRA/Rapid Rural Appraisal (RRA) was that it raised the expectation of farmers for receiving support for their irrigation system, which was not coming (ibid).

IIMI was also asked for the process documentation of implementation of the Rajapur Irrigation project in west Nepal and this was also the first study of its kind. The study has influenced the design of the project in relation to water rights, type of organization and resource mobilization based on the discussions held with the farmers (Pradhan Forthcoming).

Some other methodological contributions from the study of irrigation systems were the development of methods for the inventory of FMIS outlining the steps from selection of sites to data collection and analysis by involving farmers (Yoder 1994; IIMI 1994), and emphasizing the importance of farmers' participation and learning from them. Therefore, the representative of farmers' group from the successful irrigation organization presented the papers in the workshop, which was also attended by policymakers (Pradhan et al. 1992). The purpose was to facilitate interaction between the farmers and the agency officials and to strengthen the NGOs capability to enable them to participate in interventions according to the needs of the agency and project consultant.

IIMI applied the methodology of process documentation through the IMTP research project by conducting an extensive documentation of the management transfer of irrigation systems with focus on technical and socio-institutional aspects. The documentation was important in providing insights into the strengths and weaknesses of the processes of management transfer, and in suggesting the corrective measures required in future management transfers. Besides, the data gathered during the process documentation served as a benchmark for future comparisons.

### ***Water Management in River Basins***

Another important methodological contribution was on the development of the methodology for river basin study and its application through basin level studies in the Indrawati River Basin, which was also the first of its kind in the water management sector in Nepal. The study took the river basin as a unit and identified major components for the study, which provided a framework for future studies. The impact of this study was the application of the same framework for the study on 'Development of Effective Water Management Institutions in East Rapti'. This has enabled time saving and provided an opportunity to test the rigor of the methodology developed for river basin study. Likewise, the methodology developed for estimation of environmental flow allocations in East Rapti is also an important contribution for basin level study. The model used in this study would be beneficial for application in studies of other river basins as well.

The action research in the Begnas River Basin in western Nepal was carried out to operationalize the subbasin level committee as envisaged in the Water Resources Strategy, 2002, of the GoN (Pant and Scott 2005). The study organized the 'platform' of the concerned stakeholders for the management of resources in the basin. The methodological contribution was documentation of the processes and steps followed in the formation of the 'platform' of stakeholders, and are important in organizing subbasin and basin level committees by the government in other basins when the National Water Plan (2005) is fully implemented (Pant and Shrestha 2009). The application of this

process in other river basins is yet to be made to observe if it is replicable in a different physical, technical and socioeconomic environment.

### ***Gender and Irrigation***

Similarly, the application of a framework for gender study (Zwarteveen 1997; van Koppen et al. 2001), smallholder irrigation (Upadhyaya et al. 2005; Pant et al. 2006) and livelihood coping strategies (Lamichhane 2008) provides a framework for study on the role of gender in irrigation management.

### **Institutional Strengthening and Capacity Building**

One of the objectives of the IWMI program in Nepal was to strengthen the research capability of the Nepali researchers. IWMI research in Nepal was carried out by IWMI researchers, local researchers, WECS and DoI engineers, University teachers and students with inputs from the IWMI researchers at the office headquarters. Their involvement in IWMI research work was a form of on-the-job training due to knowledge sharing between the local and international researchers. This has helped in local capacity building in the following ways:

- Enhancing the knowledge base.
- Developing research skills.
- Exposure to various research tools and methodologies used by IWMI, especially in cross-country studies.
- Familiarization with crosscutting issues.
- Contacts with IWMI's national and international staff.
- Better access to IWMI's research findings and publications.
- Paper presentation and participation in national, regional and international workshops.

Given IWMI's mandate to strengthen the national capacity by working with the national institutes, the Institute interacted frequently with officials and academics who were involved or interested in the water sector of Nepal, even though it was working mainly with the DoI and WECS. IWMI provided an opportunity for government officials and other researchers to make exposure visits locally to enable them to understand the ground situation of water management based on the reality of the field. Under various projects, the government officials also received training, which was helpful in strengthening their knowledge and skills.

Strengthening of WECS capabilities through studies on FMIS and collaborative research work was an important contribution on human resource development (Rao and Abeywickrema 1992). Part of the research grant provided for the IMTP study was allocated directly to the RTDB of DoI, IAAS, under the Tribhuvan University, and WECS for its capacity building activities. Likewise, a research grant was allocated to WECS for its institutional strengthening from the river basin study carried out in Indrawati. Some of the important work leading to institutional strengthening of DoI was as follows:

- Input to DoI in establishing a monitoring and evaluation system based on three performance datasets: agricultural performance, operational performance, and maintenance performance.

- Increased awareness about the need for post-transfer support in management transferred systems has led to inclusion of more articulated post-transfer support extending arrangements in IMT agreements between the WUAs and the agency.

Students from Tribhuvan University and universities outside Nepal were supported in conducting research for their master's thesis. This helped in building local capability as well. Likewise, the opportunities to IWMI staff from other countries to be involved in the research work in Nepal have enhanced their knowledge base on various aspects, helped develop international contacts, fostered their research capacities and contributed toward understanding cross-country scenarios and views on IWMI's areas of interest.

IWMI also provided an opportunity for foreign students to work as interns, which was helpful in knowledge transfer and strengthening their knowledge through experience of working with IWMI researchers in the developing countries.

## **CHALLENGES AND STRATEGY FOR IWMI'S WORK**

### **Challenges**

At the beginning of IWMI activities in Nepal the main thrust was on research on FMIS. Earlier work laid the foundation for research activities in Nepal and was highly appreciated. IWMI generated funding on its own for research activities in Nepal, as the GoN did not allocate separate funding for the IWMI-Nepal program. Not being a consulting firm, it did not compete for consultancy work under various projects in Nepal. The only way it could generate funds was through donors by writing proposals. The writing of proposals and getting it funded is a long process and used to sometimes take up to 2 to 3 years. Therefore, lack of a perennial source of funding has an impact on implementing long term projects in Nepal. The situation improved from the mid-1990s and three projects were implemented successively.

Due to the internal conflict since 1998, the security environment in the country was not conducive for field research activities. IWMI's office was not closed but smaller activities, as part of regional and global projects, were implemented until funding for the three-year project under the CPWF was made available in 2005. At present the major challenge for IWMI in Nepal is to strengthen its activities in a self-sustained way by increasing the level of funding. Raising adequate resources for increased activities is important in this respect. IWMI is mainly working with two of the government agencies - WECS and DoI. Their expectation always is that IWMI should generate necessary funding for research in their priority areas, as government expenditure for research activities is minimal. Since IWMI would not be able to carry out all the research anticipated by these government agencies, caution should be maintained in not raising their expectations, which, if not fulfilled, could negatively influence the relationship with them. At the same time, it is also necessary for IWMI to maintain a minimum level of activity that is appreciated by the partner agency, where it has office. At present, this is also a challenge for IWMI activities in Nepal.

### **Strategy**

The objective of IWMI's work in Nepal should be to strengthen the efficient and effective utilization of the already developed irrigation and water resources potential in Nepal through the establishment of joint activities between relevant organizations of the government, NARES,

academic institutions, NGOs and IWMI. IWMI's research-based knowledge places it in a position to provide key information and analysis relevant for water sector policy development and effective project implementation as envisaged in GoN's Water Resources Strategy (GoN 2002) and National Water Plan (GoN 2005). IWMI has a comparative advantage in achieving this objective due to its long-term involvement in Nepal's water sector.

- IWMI can use its expertise and research experience gained in several countries, particularly in the Asian region, and combine them with local knowledge generated in Nepal; and
- IWMI is able to follow and provide timely inputs on key water management issues.

Nepal is actively engaged in several water resource development and management projects, the success of which often depends on getting the right blend of technical, institutional, and management inputs. IWMI can provide project support by supplying objective reviews of the implementation process and results, and give recommendations on how these can be carried out better. IWMI has a policy to involve key partners and stakeholders in the design and implementation of research activities, which could be further strengthened. Opportunities to implement action research studies on the effect of climate change on water management and water management at basin-scale with selected partners should be explored, which will bring researchers and practitioners more closely together in order to test, and where necessary, to modify research hypotheses, in operational conditions.

Since the beginning of its work in Nepal, IWMI, has made important and effective relationships with two of the government agencies. The recent reorganization of the government has split the Ministry of Water Resources into two - Ministry of Irrigation and Ministry of Energy. Therefore, IWMI will have to establish its relationship with the new ministry as well, and they are the lead agencies in the water sector of the country and any policy influence has to be initiated through these agencies. IWMI is working with a range of partners (NARES, universities, INGOs, Community Based Organizations), besides the two government agencies. The relationship with these agencies is based on collaborative research, research support (MSc and PhD Students) and knowledge sharing.

It is expected that a range of relationships will develop with the strengthening of the activities and that can be expanded to establish further relationships with other INGOs in the region. In Nepal, as elsewhere, NGOs and INGO's continue to play an important role in the water sector. IWMI has recognized the additional capacity of such organizations to be able to disseminate research findings through field projects. The IWMI-Nepal Consultative Committee is well established and provides an effective mechanism for regular communication between IWMI researchers, practitioners and other researchers that IWMI's research supports.

## CONCLUSIONS

IWMI's collaboration with government agencies and other institutions helped design research-based policy reform in the water management sector of Nepal. The development of mechanisms to provide assistance to FMIS and introduction of a participatory approach in irrigation management were the major policy contributions in earlier research which made policymakers aware of the need for improvements in public sector irrigation systems in Nepal. The most visible policy change was the initiation of management transfer processes in AMIS. The formation of WUAs, introduction of ISF and trainings on various aspects of irrigation management helped strengthen their role in O&M of irrigation systems. The impact, however, is mixed, as smaller irrigation systems are doing well and larger systems are not. All the recommendations of the research findings, however, were not implemented, leading to some confusion on the roles and responsibilities of users and the agency. The collaborative research led to the recognition of women's role in decision making of both FMIS and AMIS by ensuring their representation in the WUA. This was a major policy reform in irrigation management.

The studies on groundwater were important in suggesting policy reforms for expansion of groundwater in the Terai of Nepal. The focus was on exploring the possibilities of organizing users for electricity distribution for the expansion of groundwater irrigation in the Terai. This was necessary to increase smallholder's access to groundwater irrigation through electrically operated small pumps, as diesel operated engines were too expensive for them. The research recommendations have not been implemented yet due to lack of a proper groundwater policy. The river basin studies were carried out at a time when the government was embarking on IWRM. The studies suggested policy reform in the planning and management of water resources at basin-scale by taking a holistic approach, and it suggested for appropriate institutional mechanisms, which were adopted in the Water Resources Strategy of the government. A follow-up action research on the processes through which the river basin committees are formed was carried out and is expected to assist in the implementation of the National Water Plan of the government.

IWMI's collaborative research with various partners was helpful in developing methodologies for studies on irrigation management, basin, gender and institutions. The development of PRA tools, intervention criteria for supporting FMIS, users' participation in research, and process documentation of research methods provides guidelines for research on FMIS and AMIS. As all the collaborative research was conducted with local partners, the institutional strengthening and capacity building of the participating agencies has been an integral part of the research undertaking. Development of research skills, institutionalizing research activity in government agencies and learning from the research across and between the regions has enhanced the knowledge base of both national and international researchers.

Overall, challenges exist to sustain IWMI activities in Nepal, and strategically it is important to strengthen and expand IWMI's partnerships for future activities in Nepal.

## REFERENCES

- Adhikari, K. R.; Pant, D. 2003. *Irrigation intervention: A strategy for conserving biodiversity and improving food security in Royal Chitwan national park bufferzone, Nepal*. In ICID Asian Regional Workshop, Sustainable Development of Water Resources and Management and Operation of Participatory Irrigation Organizations, November 10-12, 2003, The Grand Hotel, Taipei, Taiwan. Taipei, Taiwan: International Commission on Irrigation and Drainage.
- Bandaragoda, D. J. 2005. *Stakeholder participation in developing institutions for integrated water resources management: Lessons from Asia*. IWMI Working Paper 96. Colombo, Sri Lanka: International Water Management Institute.
- Bhattarai, M.; Pant, D.; Mishra, V. S.; Devkota, H.; Pun, S.; Kayastha, R. N.; Molden, D. 2002. *Integrated development and management of water resources for productive and equitable use in the Indrawati River Basin, Nepal*. IWMI Working Paper 41. Colombo, Sri Lanka: International Water Management Institute.
- Devkota, H. 2001. Process documentation research of Melamchi Water Supply Project. In Kayastha, R. N.; Parajuli, U.; Pant, D.; Sharma, C. (eds.), *Integrated development and management of water resources: A case of Indrawati River Basin, Nepal. Proceedings of a workshop organized by Water and Energy Commission Secretariat (WECS) and IWMI. Kathmandu, Nepal, April 25, 2001*.
- Frederiksen, H. D.; Vissia, R. J. 1998. *Considerations in formulating the transfer of services in the water sector*. Colombo, Sri Lanka: International Water Management Institute
- Gosselink, P.; Guijt, I.; Thompson, J. 1995. *Livelihood strategies and performance indicators: Understanding irrigation from water-users' perspectives: A Collaborative Research Project of the International Irrigation Management Institute, and the International Institute for Environment and Development*. Colombo, Sri Lanka: International Irrigation Management Institute (IIMI); London, UK: International Institute for Environment and Development (IIED).
- Gosselink, P.; Strosser, P. 1995. Participation in irrigation management research: IIMI's application of PRA. In: Shivakoti, G.; Varughese, G.; Ostrom, E.; Shukla, A.; Thapa, G. (eds.), *People and participation in sustainable development: Understanding the dynamics of natural resource systems - Proceedings of an international conference, March 17-21, 1996, Institute of Agriculture and Animal Science, Tribhuvan University, Rampur, Chitwan, Nepal*.
- GoN (Government of Nepal). 2002. Water Resources Strategy, Nepal. Water and Energy Commission Secretariat (WECS), Kathmandu, Nepal.
- GoN (Government of Nepal). 2005. National Water Plan. Water and Energy Commission Secretariat (WECS), Kathmandu, Nepal.
- IIMI (International Irrigation Management Institute). 1992. Final report submitted to the Department of Irrigation and USAID Mission to Nepal, Agricultural and Rural Development Office. Vol. 1 - Increasing water user participation in irrigation management. Phase 1 - Field testing alternative approaches, Main report; Vol. II -Institutional Development; Vol. III - Main canal management in Banganga Irrigation Systems; Vol. IV - Administrative linkages analysis of Banganga irrigation system, Kapilbastu District, Nepal. Kathmandu, Nepal: International Irrigation Management Institute. 4 volumes.
- IIMI. 1994. Final Report. Program on Farmer Managed Irrigation Systems and Support Services. Phase II Vol. 2 - Comparison of support services for farmer managed irrigation systems in Sri Lanka and Nepal. Report submitted to IFAD and BMZ in October 1994.
- IWMI (International Water Management Institute). 2000. Evaluation of management transfer performance and process, Nepal. Project Completion Report (September 1996 – April 2000) submitted to Ford Foundation. Colombo, Sri Lanka: International Water Management Institute. 17p.
- IWMI. 2001. Integrated development and management of Nepal's water resources for productive and equitable use. Unpublished project completion report (December 1999 -December 2001) to the Ford Foundation. New Delhi, India: International Water Management Institute. 40p.
- IWMI. 2003a. Development of effective water-management institutions, final report, vol. IV: country study reports and action plans. Colombo, Sri Lanka: International Water Management Institute (IWMI). vi, 185p.
- IWMI. 2003b. Sustainable resource management for improved livelihood (CP 23). Project proposal submitted to CGIAR Challenge Program on Water and Food (CPWF). Colombo, Sri Lanka: CPWF.
- IWMI. 2003c. Study on multiple use schemes. Project proposal submitted to IDE, Nepal. Kathmandu, Nepal: International Water Management Institute.
- Joshi, K. M.; Kansakar, D. R.; Gautam, K. R. 2002. Energy implication on ground water irrigation: A case of Nepal. Final report (unpublished), Kathmandu, Nepal.

- Kalu, I. 2003. An assessment of IDE-Nepal's low cost drip irrigation technology. Final report document 2 of 9, of an IWMI research project supported by DFID. vi, 77p. (IWMI background paper).
- Kansakar, D. R.; Pant, D. R.; Chaudhary, J. P. 2009. Reaching the poor: Effectiveness of the current shallow tubewell policy in Nepal. In: Mukherji, A.; Villholth, K. G.; Sharma, B. R.; Wang, J. (eds.), *Groundwater governance in the indo-gangetic and yellow river basins: Realities and challenges*. London, UK: CRC Press, Taylor and Francis Group.
- Kayastha, R. N.; Parajuli, U.; Pant, D.; Sharma, C. (eds.). 2001. Integrated development and management of water resources: A case of Indrawati River Basin, Nepal. *Proceedings of a workshop organized by Water and Energy Commission Secretariat (WECS) and IWMI. Kathmandu, Nepal, April 25, 2001*.
- Lamichhane, A. R. 2008. *Women's coping strategies in the context of male out-migration: A case study of Kaski District, Nepal*. A thesis submitted in partial fulfillment of requirement for the Degree of Masters of Science in Gender and Development Studies. Bangkok, Thailand: Asian Institute of Technology.
- Maglinao, A. R.; Leslie, R. N. (eds.). 2001. *Soil erosion management research in Asian catchments: Methodological approaches and initial results. Proceedings of the 5th Management of Soil Erosion Consortium (MSEC) Assembly, held at Semarang, Central Java, Indonesia, November 7-11, 2000*. Bangkok, Thailand: International Water Management Institute, Southeast Asia Regional Office.
- Martin, E. D.; Pradhan, P.; Adriano, M. S. 1989. Financing irrigation services in Nepal. In: Small, L. E.; Adriano, M. S.; Martin, E. D.; Bhatia, R.; Shim, Y. K.; Pradhan, P. (eds.), *Financing irrigation services: A literature review and selected case studies from Asia*. Colombo, Sri Lanka, International Irrigation Management Institute.
- Mishra, V. S.; Molden, D. J. 1996. *Management turnover in the West Gandak Irrigation System, Nepal*. Short report series on locally managed irrigation. Report No. 14. Colombo, Sri Lanka: International Irrigation Management Institute.
- Mishra, V. S.; Shilpakar, R. L. 2001. Water accounting study in Indrawati River Basin in Nepal. In: Kayastha, R. N.; Parajuli, U.; Pant, D.; Sharma, C. (eds.), *Integrated development and management of water resources: A case of Indrawati River Basin, Nepal. Proceedings of a workshop organized by Water and Energy Commission Secretariat (WECS) and International Water Management Institute (IWMI). Kathmandu, Nepal, April 25, 2001*.
- MOU (Memorandum of Understanding). 1994. Government of Nepal and International Water Management Institute.
- Molden, D. J. 2000. Powerpoint presentation on project objectives and methodology for developing institutions for integrated water resources management to the stakeholders in Kathmandu (Unpublished).
- Molden, D.; Sakthivadivel, R. 1999. Water accounting to assess use and productivity. *Water resource Development* 15(1-2): 55-71.
- Pant, D. R. 2001. Formal and informal institutions on water management in Indrawati River Basin in Nepal. In: Kayastha, R. N.; Parajuli, U.; Pant, D.; Sharma, C. (eds.), *Integrated development and management of water resources: A case of Indrawati River Basin, Nepal. Proceedings of a workshop organized by Water and Energy Commission Secretariat (WECS) and International Water Management Institute (IWMI). Kathmandu, Nepal, April 25, 2001*. Kathmandu, Nepal: Water and Energy Commission Secretariat (WECS) and International Water Management Institute (IWMI).
- Pant, D.; Scott, C. 2005. Forest-watershed-irrigation linkages: Policy support for integrated management. In: Sharma, B.; Samra, J. S.; Scott, C.; Wani, S. P. (eds.), *Watershed management challenges: improving productivity, resources and livelihoods*. Colombo, Sri Lanka: International Water Management Institute (IWMI); Indian Council of Agricultural Research (ICAR); International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).
- Pant, D.; Belbase, M. 2003. *Socio-ecological implication of ground water in Nepal*. Paper presented at IWMI-TATA Annual Partner's Workshop. January 26-29, 2003, Anand, Gujrat, India.
- Pant, D.; Gautam, K. R.; Shakya, S. D.; Adhikari, D. L. 2006. *Multiple Use Schemes: Benefit to Smallholders*. IWMI Working Paper 114. Colombo, Sri Lanka: International Water Management Institute (IWMI).
- Pant, D. 2009. *Resource Management for Sustainable Livelihood*. Project Completion Report submitted to CGIAR Challenge Program on Water and Food (CPWF). Colombo, Sri Lanka: CPWF.
- Pant, D.; Shrestha, P. 2009. Institutional Study in Begnas Basin (Unpublished).
- Pant, S. R.; Valera, A.; Pradhan, U. (eds.). 1992. National workshop on participatory management in agency-managed irrigation systems in Nepal. *Proceedings of the National Workshop on Participatory Management in Agency-managed Irrigation Systems in Nepal, Lazimpat, Kathmandu, Nepal*. Kathmandu, Nepal: Department of Irrigation; Nepal, Kathmandu: International Irrigation Management Institute; Nepal Field Operations.

- Parajuli, U.; Sharma, K. R. 2009. Study report on Resource Assessment in Begnas Basin, Kathmandu, Nepal (Unpublished).
- Pradhan, P. Forthcoming. A decade of IIMI activities in Nepal.
- Pradhan, U.; Valera, A.; Rana, S. 1992. Role of NGOs in irrigation development and management in Nepal. *Proceedings of the National Workshop on the Role of NGOs in Irrigation Development and Management in Nepal, Nepal Administrative Staff College, Jawalakhel, Lalitpur, Nepal*. Kathmandu, Nepal: International Irrigation Management Institute; Nepal: Udaya-Himalaya Network.
- Pradhan, U. 1994. Farmer to farmer training as a way of assistance to the farmers on the improvement of irrigation systems. In: Sowerwine, J.; Shivakoti, G; Pradhan, U.; Shukla, A.; Ostrom, E. (eds.), From farmers' fields to data fields and back: A synthesis of participatory information systems for irrigation and other resources. *Proceedings of an International Workshop held at the Institute of Agriculture and Animal Science, Rampur, Nepal, March 21-26, 1993*. Colombo, Sri Lanka.
- Prasad, K. C.; Sijapati S.; Pradhan, P.; Sharma, K. R.; Riddell, N. 1998. Irrigation service fees in Nepal: Evaluation of management transfer performance and process. Report of a joint study by the Department of Irrigation, Nepal, and International Water Management Institute.
- Rao, P. S.; Abeywickrema, N. 1992. Review of IIMI's experience in strengthening national capacity for irrigation management and research. Parts I and II. Colombo, Sri Lanka: International Irrigation Management Institute.
- RITI Consultants. 2001. Household survey and analysis on poverty focussed smallholder water management technologies: An assessment of IDE-Nepal's low cost drip irrigation technology.
- Rutkowski, T.; Raschid-Sally, L.; Buechler, S. 2007. Wastewater irrigation in the developing world: Two case studies from the Kathmandu Valley in Nepal.
- Samad, M. 2002. Impact of irrigation management transfer on the performance of irrigation systems: A review of selected experiences from Asia and Latin America. In Sally, H.; Abernethy, C. L. (Eds.), *Private irrigation in Sub-Saharan Africa: Regional Seminar on Private Sector Participation and Irrigation Expansion in Sub-Saharan Africa, Accra, Ghana, October 22-26, 2001*. Colombo, Sri Lanka: IWMI; FAO; ACP-EU Technical Centre for Agricultural and Rural Cooperation. pp. 139-149.
- Samad, M.; de Fraiture, C.; Prasad, K. C. 1999. Impact assessment of Irrigation Management Transfer in selected irrigation systems in Nepal. In: Parajuli, U.; Prasad, K. C. (eds.). Workshop proceedings: Evaluation of Irrigation Management Transfer Process and Performance - Workshop held in Kathmandu, October 11-12, 1999. Proceedings of workshop jointly organized by Research and Technology Development Branch (RTDB) of Department of Irrigation (DoI) and International Irrigation Management Institute (IIMI).
- Sijapati, S.; Prasad, K. C. 1998. Conclusions and recommendations of ISF study. In: Sijapati, S.; Prasad, K. C. (eds.) Workshop proceedings: Evaluation of Irrigation Management Transfer Process and Performance - Workshop held in Kathmandu, September 17-18, 1998. Proceedings of workshop jointly organized by Research and Technology Development Branch (RTDB) of Department of Irrigation (DoI) and International Irrigation Management Institute (IIMI).
- Shah, T.; Singh, O P.; Mukherji, A. 2006. Some aspects of South Asia's groundwater irrigation economy: analyses from a survey in India, Pakistan, Nepal Terai and Bangladesh. *Hydrogeology Journal* 14: 286-309.
- Shukla, A.; Dutta, J. P.; Devkota, B.; Ghimire, K.C. 1998. A paper based diagnosis of election of WUA functionaries in Nepal West Gandak Irrigation System. In: Sijapati, S.; Prasad, K. C. (eds.), Workshop proceedings: Evaluation of Irrigation Management Transfer Process and Performance - Workshop held in Kathmandu, September 17-18, 1998. *Proceedings of workshop jointly organized by Research and Technology Development Branch (RTDB) of Department of Irrigation (DoI) and International Irrigation Management Institute (IIMI)*.
- Sijapati, S.; Prasad, K. C. (eds.). 1998. Workshop proceedings: Evaluation of Irrigation Management Transfer Process and Performance - Workshop held in Kathmandu, September 17-18, 1998. *Proceedings of workshop jointly organized by Research and Technology Development Branch (RTDB) of Department of Irrigation (DoI) and International Irrigation Management Institute (IIMI)*.
- Smakhtin, V. Shilpakar, R. L. 2005. *Planning for environmental water allocations: An example of hydrology-based assessment in the East Rapti River, Nepal*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 25p. (IWMI Research Report 89).
- Smakhtin, V. U.; Shilpakar, R. L.; Hughes, D. A. 2006. Hydrology-based assessment of environmental flows: An example from Nepal. *Hydrological Sciences Journal* 51(2).

- Small, L. E.; Adriano, M. S.; Martin, E. M. 1986. Regional study on irrigation service fees: Final report. Digana Village, Sri Lanka: International Irrigation Management Institute. 5p.
- Small, L. E.; Adriano, M. S.; Martin, E. D.; Bhatia, R.; Shim, Y. K.; Pradhan, P. 1989. Financing irrigation services: A literature review and selected case studies from Asia. Colombo, Sri Lanka: IIMI. ix, 286p.
- Shilpakar, R. L.; Pant, D. 2004. Study on community based hydropower and electricity management and its application to community managed tubewells in Nepal (unpublished). Kathmandu, Nepal.
- Upadhyaya, S. 1999. Institutional development processes for IMT: A review. In: Parajuli, U.; Prasad, K. C. (eds.), *Workshop proceedings: Evaluation of Irrigation Management Transfer Process and Performance - Workshop held in Kathmandu, October 11-12, 1999. Proceedings of workshop jointly organized by Research and Technology Development Branch (RTDB) and International Irrigation Management Institute (IIMI)*.
- Upadhyaya, S. 2001. Stakeholder's inclusion and exclusion process in the Indrawati River Basin: A review. In Kayastha, R. N.; Parajuli, U.; Pant, D.; Sharma, C. (eds.), *Integrated development and management of water resources: A case of Indrawati River Basin, Nepal: Proceedings of a workshop organized by Water and Energy Commission Secretariat (WECS) and International Water Management Institute (IWMI). Kathmandu, Nepal, April 25, 2001*.
- Upadhyaya, B.; Samad, M.; Giordano, M. 2005. *Livelihoods and gender roles in drip irrigation technology: A case of Nepal*. Colombo, Sri Lanka: International Water Management Institute. (IWMI Working Paper 87).
- van Etten, J.; van Koppen, B.; Shuku, P. 2002. *Do equal land and water rights benefit the poor? Targeted irrigation development: The case of the Andhi Khola Irrigation Scheme in Nepal*. IWMI Working Paper 38. Colombo, Sri Lanka: International Water Management Institute.
- van Etten, J.; Bajracharya, P.; Tuladhar, A.; van Koppen, B. 1999. Participation of women in West Gandak Water Users' Association. In: Parajuli, U.; Prasad, K. C. (eds.), *Workshop proceedings: Evaluation of Irrigation Management Transfer Process and Performance - Workshop held in Kathmandu, October 11-12, 1999. Proceedings of workshop jointly organized by Research and Technology Development Branch (RTDB) of Department of Irrigation (DoI) and International Irrigation Management Institute (IIMI)*.
- van Koppen, B.; van Etten, J.; Bajracharya, P.; Tuladhar, A. 2001. *Women irrigators and leaders in the West Gandak Scheme, Nepal*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 35p. (IWMI Working Paper 15).
- van Koppen, B. 2001. Gender in integrated water management: An analysis of variation. *Natural Resources Forum* 25: 299-312.
- Yadav, S. D. 1998. Deliberation on West Gandak Irrigation System (in Nepali). In: Sijapati, S.; Prasad, K. C. (eds.), *Workshop proceedings: Evaluation of Irrigation Management Transfer Process and Performance - Workshop held in Kathmandu, September 17-18, 1998. Proceedings of workshop jointly organized by Research and Technology Development Branch (RTDB) of Department of Irrigation (DoI) and International Irrigation Management Institute (IIMI)*.
- Yoder, R.; Pradhan, P.; Martin, E. 1988. Recommendation for consideration in the development of Nepal's Irrigation Master Plan. Part 1 - Management of irrigation systems for effective O&M and resource mobilization; Part 2 - Farmer-Managed Irrigation Systems. Digana Village, Sri Lanka: International Irrigation Management Institute (IIMI). 22p. (IIMI Occasional Paper).
- Yoder, R. 1994. Data management, analysis and report writing for a field based resource inventory survey. In: Lauraya, F. M.; Wijayarathna, C. M.; Vermillion, D. L. (eds.), *Information Support Systems for Farmer Managed Irrigation Systems. Selected Proceedings of the Asian Regional Workshop on the Inventory of Farmer Managed Irrigation Systems and Management Information Systems held at Tagaytay City, the Philippines*. Colombo, Sri Lanka: International Irrigation Management Institute.
- Zwarteveen, M. 1997. Free-riders or victims: Women's non-participation in irrigation management in Nepal's Chhatis Mauja Irrigation Scheme. *Journal of Applied Irrigation Science; Zeitschrift fur Bewässerungswirtschaft* 32(1): 113-116.

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[http://publications.iwmi.org/pdf/H\\_5909.pdf](http://publications.iwmi.org/pdf/H_5909.pdf)

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